# CURRENT SCIENCE

Vol. XV] MARCH 1946 [No. 3



## THE SCIENTIFIC INSTRUMENT INDUSTRY

THE scientific instrument industry has been universally recognised as one of the "key" or the "pivotal" industries, essential for the promotion of research and indispensable for the development, improvement and standardisation of other industries. The spectacular services which the industry rendered during the war have augmented this recognition and raised its prestige. The industry has played a fundamental role in the development of the modern weapons of war, almost human in its operational skill and unerring in the pursuit of its target. Great ingenuity and resourcefulness have been displayed in the instrumentation of industrial machinery and industrial processes. This has led to an all-round rationalisation of industry contributing towards a degree of precision which had not been attained before and securing an enviable measure of economy of time and man-power; these constituted vitally important gains for the war effort.

Instrumentation has accelerated the speed of research; it has been responsible for eliminating physical strain and fatigue in scientific work and for effecting a considerable reduction of the personal and accidental errors incidental to experimental investigations. Improved instruments have facilitated and enlivened the teaching and the demonstration of the principles of science; the industry provides the tools for the training of scientists and technologists needed for the creation, expansion and maintenance of industries. Scientific instruments group themselves into (1) instruments for purposes of instruction and demonstration in schools and colleges, (2) those needed for pure and applied research, (3) those which are essential for the control of industrial machinery and technological processes, (4) those which are employed in the standardisation of industrial products, and (5) those connected with problems of national defence, and thus encompass every phase of our national life and existence.

For practically every type of instrument India is dependent upon foreign supplies; our national contribution to the science of instruments and instrumentation has been regrettably insignificant. During the war, scientific investigators in this country became painfully conscious of the heavy price the nation had to pay for having, in the past, neglected to develop this key-industry. Just at a time when the Government launched upon a programme of intensive research and industrialisation the scientists found themselves faced with an embarrassing shortage of the essential tools of research, whose supplies have since become increasingly scarce. The scientists themelves, we are afraid, must largely accept the responsibility for this critical situation, since the development of a scientific instrument industry is their exclusive privilege. It is instructive to recall that in the early days of scientific enquiry, scientific men made their own instruments and later, the rise of the instrument industry in Germany and England was closely associated with historic men of science. Far-sighted governments, like that of Germany,

extended their support to the industry and helped to establish intimate collaborations between scientists and manufacturers. One of the most classical of such collaborative enterprises, famous in the history of scientific instruments, is the one which the German Government brought about between Prof. Abbe and the firm of Schott in Jena. In the early days of the last war, the British Government created a Department of Scientific and Industrial Research; the very first task which the Department took up was the problem of rejuvenating the industry of scientific instruments and of the optical and laboratory glasses, through both of which the essential tools of research are forged. The instrument industry in Britain has, in recent years, occupied a privileged position in its national economy; although its direct economic importance is relatively small, its indirect value is recognised to be out of all proportion to its size. The status and prosperity of the scientific instrument industry of a nation, is accepted to constitute a true measure at once of the efficiency and advance of scientific education and research as well as of the economic stability and technological excellence of its manufacturing industries.

The responsibility for the disheartening backwardness of the scientific instrument industry in India should be shared by four groups of agencies; first by the Government who have not encouraged the establishment of this key industry; secondly by the scientists and technologists who have not organised themselves and secured a self-sufficiency for the country with respect to the essential tools and accessories for scientific education and research, thirdly, by the industrial manufacturers who have not yet become sufficiently instrument-minded to lend their support to the industry; and fourthly, by the trading firms who should undertake the responsibility of creating an indigenous manufacturing industry in the country. During the war, a few enterprising firms have tried to establish the nucleus of a manufacturing industry; they have worked under great difficulties and severe handicaps; their heroic and sincere attempts to serve the scientific workers during the war years will be gratefully acknowledged.

The present appears to offer a propitious moment for launching upon a five-year plan for the development of this industry and in accomplishing this task all the four agencies should participate and co-operate; the Government by extending their financial support and offering tariff protection, the scientists by placing their experience at the disposal of the industry and through research, the industrialists by encouraging the instrumentation of their industrial equipment and processes and the trade by organising the manufacture of instruments in their own workshops.

The universities and the research institutes can play an extremely inspiring and constructive role in contributing to the development of the industry; they can inaugurate courses in applied physics with special reference to scientific instruments and industrial instrumentation; they can initiate research on fundamental and applied aspects of scientific instruments. The Council of Scientific and Industrial Research has already financed quite a few schemes which have a direct bearing on the manufacture of scientific instruments. The National Physical Laboratory will, we have no doubt, include a section for the study of scientific instruments. Polytechnic Institutes which are expected to come into being in the next few years, might appropriately offer facilities for training in precision mechanics, instrument design and instrument making; these institutes should be able to provide a continuous flow of competent technical personnel for the instrument industry. The immediate needs of the industry with respect to precision mechanics could, however, be met by a selection from among the "Bevin Boys", and the hundreds of skilled personnel trained in the Ordnance Factories, Munition Workshops and the Hindustan Aircraft Factory. The skilled labour which has been developed during these war years should not be allowed to languish and the scientific instrument industry and the fabrication of chemical plant, if started, could absorb almost the entire quantity of skilled labour now threatened with retrenchment.

With a view to speed up the progress of the industry, it may be advisable to entertain, for short periods, the services of a few top-ranking specialists experienced in this line, who would undertake to train some of our young men during the period of their contract. Large number of such experts from Germany have gone to Britain and America and it is reported that several hundreds of them have been 'removed' by the Russians. A few may still be available in Germany and other parts of the war-devastated Europe; they would eagerly accept an invitation from this country with gratitude and undertake to assist us in developing this industry. The task of choosing these experts may well be entrusted to a Technical Mission which should be deputed to England, America and Germany, who should also be entrusted with the task of studying the industry in all its bearings, and of securing the necessary capital equipment. The Technical Mission should be composed of the instrument-minded and active scientists, creative engineers and shrewed businessmen connected with the instrument trade.

In an editorial on the Scientific Equipment Industry, the *Journal of Scientific and Industrial Research* (1944, *2*, 75) entered a strong plea for a pooling of the experience acquired by the scientific workers; it was suggested that the information thus made available should be edited and published and a five-year plan drawn up for making the country self-sufficient with respect to the scientific instruments and laboratory chemicals. We earnestly hope that our leading men of science will take up this task immediately and secure the generous support of the Government for establishing this key industry on a broad and enduring foundation.

# THE UNDERGROUND GASIFICATION OF COAL IN THE U.S.S.R. ITS POSSIBILITY IN INDIA

By M. R. MANDLEKAR

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## Introduction

ALTHOUGH credit is due to Mendeleev (1888) for the first suggestion that coal may be gasified *in situ*, and to Ramsay (1912) who had actually proposed to carry out the work on an experimental scale at a Colliery in Durham, but which was subsequently abandoned due to the outbreak of the World War (1914), it was mainly due to the interest taken in the scheme by the Soviet Government that some preliminary experiments were subsidised (1931). The work was later included in their five-year plans and the scheme has been in operation in certain Russian coal basins on an industrial scale.

References have been made to the method in literature but it is only recently that more information in this regard has been available. Jolley and Booth (*Fuel in Science and Practice*, 1945, 24, 31) have surveyed the literature on this subject.

It is interesting to note that the method has been made applicable to coal beds which are difficult or unprofitable to work by ordinary mining methods owing to the low grade of coal, tendency to spontaneous combustion, thin seam, and other reasons. The outstanding features of the scheme have been described in the article. The principal methods are outlined below.

## Methods

The 'Bore-hole-producer Method' is suitable for horizontal or slightly inclined seams, especially if the roof is porous or unstable. For this purpose two galleries are constructed within the seam to serve blast-inlet and gas-offtake manifolds; the galleries are connected by a number of parallel bore-holes. Shafts (about 2 ft. diameter) for blast and gas are constructed to connect the galleries to the surface. The coal panel is ignited and the fire spreads gradually yielding lean or rich gas according to the composition of the blast (with or without oxygen).

For the operation of the 'Stream Method' two or more galleries, following the dip of the seam, are joined by a horizontal gallery. A panel may have more than 12,000 tons of coal. Fire is lighted in one of the panels and blast (enriched with oxygen) is supplied through a shaft. The combustion zone advances upwards towards the roof and the accumulated ash and any material from the roof do not readily block or engulf the unburnt coal. A principal feature of the method is the small number of labourers required for underground operations.

The 'Percolation (or Filtration) Method' depends on the formation of shrinkage cracks and fissures in the coal when heated, so that it becomes readily permeable to gas. A number of bore-holes, arranged in concentric rings, are made and blast and gas-pipes are fixed in them. The coal at the bottom of one of the holes is ignited and the combustion is maintained by supplying air and/or oxygen through the blast pipe. The gaseous products formed develop fissures in the coal mass allowing them to pass up through the adjacent openings.

In addition to the above main systems a number of combinations suitable under different working conditions have been practised. During the progress of the operations precautions have to be taken to check the spread of fire by constructing brick walls in the underground galleries. The shafts have to be suitably lined. There are a number of other operations requiring careful observation and control and for a number of them mechanical controlling devices have been adopted.

## Advantages

It has been claimed that underground gasification enables the full value (80-90 per cent.) of the coal to be won, whereas even highly mechanised mining methods enable only 60 per cent. of the coal worked to be utilised.

Low quality producer gas (100-150 B.T.U./cu. ft.) is manufactured in the process; however, in certain cases with the use of oxygen (from neighbouring chemical works) in the blast the quality of the resulting gas is improved. It is even suggested that the gas could be stripped of its hydrogen content which may be utilised for the synthesis of liquid fuel by the Fischer-Tropsch process and for the synthesis of ammonia required for the fertilizer industry.

The gas is mainly used for the generation of electric power, for the synthetic chemical industry, and for domestic purposes. In all these fields the results achieved have been very favourable in comparison to the practice of commencing initial operations from mined coal. Giant power stations have been constructed whereby drastic saving has been effected in labour and costs. It is stated that the average output per man employed was increased from 30 tons of coal per month by mining methods to the thermal equivalent of 100-120 tons per month in the underground gasification scheme. While formerly about 70 per cent. of the labour employed in Russian coal mines was engaged in underground operations, in the underground gasification stations only 15 per cent. is necessary. On thermal basis the labour requirement of the underground gasification station is 5-6 times less than in coal mine.

The cost of production of lean gas (100-150 B.T.U./cu. ft.) has been stated to amount to about 0·375-0·5 pence per therm (100,000 B.T.U.) and that of rich gas (250 B.T.U./cu. ft.) to 1·0 pence per therm. The capital cost of an underground gasification plant is 60-70 per cent. of that of a plant employing above-ground producer. For a combined underground gas-electric power generating station the capital cost is given as 1,500 roubles per K.W. installed power (i.e., about £60) and the

prime cost of power as 4-6 kopek per Kw. hr., *i.e.*, about 0·4-0·6 pence per kw. hr.

POSSIBILITY IN INDIA

The new scheme has been largely developed during the war and it is expected that the coal basins wherein the underground gasification stations are situated would provide the centres round which the large-scale industries of Russia would be developed. In India ambitious plans of industrial development are under consideration and preparation. As a preliminary step provision of cheap power is to be ensured. In those parts of the country where coal deposits are occurring, *e.g.*, Bengal, Bihar, Hyderabad (Deccan), Central Provinces and certain Central Indian States, plans for the erection of giant thermal power stations are being probably prepared so that cheap power may be available in the coal areas wherein would be located the large-scale industries of the respective provinces. The projected power stations perhaps may have been designed to utilise mined (inferior quality) coal. The success achieved by the underground gasification methods, in the U.S.S.R., should not be overlooked by the authorities concerned in this country.

It is necessary to stress that the coal resources of this country are limited and, in the light of the experience gained in Russia, low grade coal (some of which has been regarded as unprofitable to mine) and, an appreciable proportion of it, may be fruitfully utilised in the interest of the country.

*Note.*—The cost of printing this contribution has been defrayed by a generous grant from the Rockefeller Foundation for the publication of results of scientific work made to us through the kindness of the National Institute of Sciences, India. *Ed.*

## MUSEUMS ASSOCIATION OF INDIA*

THE Museums of India, which, as those elsewhere, have been victims of great havoc during the war, are now being gradually restored to their normal condition. Various organisations, such as the International Museums Office at Paris and others, have already resumed work and are drawing up plans for the promotion of human culture, and it is hoped that the Museums Association of India will associate itself with such organisations.

Reference should be made here to the sad demise of Mr. Manindranath Dutta-Gupta, in whom the Taxila Museum has lost a most devoted Curator.

The Association has successfully started the publication of its own Journal, and it is hoped that in addition to the two numbers of the Journal in a year, a separate brochure on museum administration will be issued in the near future. Another noteworthy activity of the Association was to draw up a comprehensive questionnaire on topics relating to museum reconstruction. While some museums have given answers conducive to museum improvement, many of the smaller museums and those under the Government of India have remained indifferent to the questionnaire, scarcely realising that the attainment of a high standard depends largely on their contacts with non-official associations.

While, in India, the growth of museums has been intolerably slow, in America and Russia, museums not only increase rapidly in size and numbers but are also inextricably linked up with visual education. Indian museums will greatly benefit themselves by actively participating in an universal educational drive. Labelling, again, presents more difficult problems in India than in other countries, and it is often necessary to have labels written in four or five languages. The present moment is particularly opportune for strengthening the museum movement in the Madras Province, for the Madras Museum had its origin here exactly a hundred years ago and it is most fitting that the completion of the five-year developmental plan of the Superintendent should mark its centenary. A special exhibition may also be held on the occasion, for exhibitions are of great educational value and museums should endeavour to direct such occasional outbursts of activity into more permanent channels. Another essential function of the Museums Association is to arrange for exchange of exhibits for the mutual benefit of museums; though historical museums may be unwilling to part with original specimens, provision may be made for exchanging duplicates, models and casts, and the Association has already made a beginning in executing such schemes.

The progress made by the museums in India during the last year has been considerable. The Baroda Museum has started issuing a six-monthly bulletin, while projects of establishing Regional Museums in different cultural centres are taking shape.

Standardised training for museum personnel is another important task of the Museums Association. For the present the opening of regular training courses for museum work in this country would be too premature, but curators may be materially benefited by working in the Archæological Survey and in the various sections of the first-rate museums in the country. It is also desirable to co-operate with the British Museums Association in this connection.

Finally, a word of thanks is due to the curators of different museums for their wholehearted support and especially to Dr. B. C. Law, the scholar-philanthropist of Calcutta, who has recently become a donor of the Association.

S. THOMAS SATYAMURTI.

* Abstract of Rao Bahadur K. N. Dikshit's Presidential Address to the Second Annual Meeting of the Association, Madras, 1945.

# RESEARCH IN DAIRYING*

PROF. H. D. Kay, Director of the National Institute for Research in Dairying, who is on a short visit to this country gave an interesting talk on the recent developments in Dairy Science, with special reference to his work in England. Outlining the origin and development of dairy research in Great Britain, he described the present relationship of the Dairy Research Institutes to the Agricultural Research Council and to other Institutes dealing with various aspects of the agricultural and industrial research. The National Institute for Research in Dairying at Reading is closely associated with the University of Reading but enjoys a good deal of autonomy and is administered by its own governing body. Co-ordination of work within the Institute is secured by a small professional Staff Committee comprised of senior members of the research staff. In addition to permanent members of the staff, post-graduate research students and visiting research workers from overseas are engaged in the various departments of the Institute on special problems. At present, five Departments exist, *i.e.*, Husbandry, Physiology, Bacteriology, Chemistry and Nutrition. In addition, a new section, the Dairy Machinery Section, is likely to reach departmental status very soon. Between them these departments cover the wide range of Dairy Science, breeding, feeding and management of dairy cows for milk production on the one hand and methods of milk distribution and even of keeping milk in the consumer's home on the other.

Dr. Kay described a few of the research problems which had been dealt by the Institute in the recent past and present. He pointed out the direct importance to the whole community of knowledge obtained of the effect of feeding and other controllable factors on the nutritional and other qualities of the milk produced. He gave an account of recent work on the control of milk quantity and quality by means of hormones and the methods by which milk had been produced from virgin and from barren animals. As regards Dairy Technology, improvements in methods of pasteurisation and the control of heat-treated milk were described. The desirability of making use of bacteriological advice in the devising and improvement of dairy appliances and dairy machinery of all kinds was emphasised. A number of problems concerned with the chemical composition of milk had been tackled and solved within the past few years. A recent and interesting finding had been that underfeeding of cows that had taken place in some districts in Britain during the war years had resulted in a fall not only in the volume but also in the nutritional quality of the milk produced. Objective methods of assessing the quality of dairy products by direct measurement of their physical characteristics had also been developed. Dr. Kay thought that in every Dairy Research Institute a Nutritional Section, where the nutritional value of milk and constituents of milk could be accurately assessed by chemical, physical and biological methods was a necessity. He also illustrated the need for the closest collaboration between the staff of the dairy research organisations dealing with specialist subjects which in many cases had an important bearing on the progress in dairy science. In his view there was a large number of unsolved dairy problems peculiar to India, in milk production, in the handling and processing of liquid milk and also in the making of Indian dairy products and in the utilisation of by-products. If these problems remained unsolved, they would continue to handicap severely the production and consumption of milk and milk products in this country and in consequence, the nutritional status of the population. It was clear that one of the most important national tasks facing India was to ensure an increased production and consumption of milk and milk products of really satisfactory quality.

* Abstract of a lecture delivered by Prof. H. D. Kay, C.B.E., D.Sc., F.R.S., on the 11th March 1946, at the Imperial Dairy Research Institute, Bangalore.

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# THE LATE MR. KAPILRAM H. VAKIL, M.Sc. (Tech.), F.I.C., F.C.S.
## A PERSONAL ESTIMATE

By S. G. SASTRY

IT was at the palatial and hospitable residence of Sir Lala Shreeram that I last met Mr. Kapilram Vakil. The occasion was the second meeting of Panel on Heavy Chemical Industries of which he was a member and Sir Lala, the Chairman. Just before lunch, all the guests had gathered in the verandah. It was given to me to discharge a very pleasant social duty. To Sir T. S. Venkataraman, the celebrated sugarcane expert, I had the privilege of presenting the late Mr. Kapilram Vakil as "the Doyen of heavy chemical industries in India". The two heroes clasped each other's hands and were beaming at each other and exchanged thoughts and ideas—so much so that Sir Lala had to gently remind them that lunch was waiting.

The incident narrated above indicates the estimate in which I held the late Mr. Kapilram. For nearly thirty-five years, he laboured in the field of chemical industries in India,—specially heavy chemical industries—as a pioneer. He went through all the vicissitudes and tribulations that beset the path of a pioneer in any country, the more so a pioneer in the field of heavy chemical industries in India. When I entered the field as a fellow-worker, Mr. Kapilram had already ten years of solid work to his credit. He welcomed me as a brother. On many an occasion when we

had to differ we sparred at each other like devils but, thank God, our friendship did not suffer. My admiration and respect for him continued unabated. We had not many opportunities to meet each other but we exchanged letters fairly often. The respect due to an elder brother and a desire to defer to his experience and counsel always formed the background of my relationship with him and he reciprocated with affection and helpfulness towards an aspiring younger brother. It was lucky for him and lucky for India that the famous house of Tatas extended their hand of help towards a newcomer in the field of industrial chemistry and chemical engineering which was not very popular at that time in Inda, and probably so, even in England. In that country chemical industries existed and flourished. But research chemists and chemical engineers were looked upon with suspicion, if not disfavour. Germany and America were forging ahead in the field of chemical industries but England was resting on her oars and content to reap the profits of an Empire trade. It was at such a time that Mr. Kapilram Vakil made his debut before industrial India chaperoned by the famous house of Tatas.

His first efforts were in the field of oil industries. He contributed his share of work in the planning and starting of the Tata Oil Mills, Ernakulam. He was one of the earliest chemical engineers in India to think of hydrogenation of oils and fats and conducted several experiments personally on a plant scale. He published a paper on "Hydrogenation Flavour" (*Chemistry and Industry*, Review Section, 1923, pp. 788-90) which was widely noticed and reviewed in the technical press and the researches that followed the publication of this paper did much to ultimately remove the hydrogenation flavour from hardened oils meant for edible purposes. But the publication of this paper made the Indian industrialists a little more cautious. The Tatas, however, ventured to put up a plant at Ernakulam but it had to be closed down after sometime in spite of the heroic attempts of Mr. Kapilram. It is unnecessary to recount the history and progress of "Tomco" with all its ramifications in the field of oil production, soap-making, hydrogenation of oils and fats and glycerine production. They are well known in India. Mr. Kapilram Vakil contributed his share for the success of these enterprises continuously.

That he was basically an industrial chemist and turned his knowledge into many useful channels is proved by the fact that he contributed a very valuable report on the bye-products of wood distillation to the Government of Mysore who were then projecting the Mysore Iron and Steel Works. This report was printed in 1920 and obviously it was meant for private circulation. As an Industrial Chemist and Chemical Engineer who later on had to spend some of his time at the Mysore Iron and Steel Works I had the privilege of going through the report. With the knowledge then available to chemical engineers, no better or abler report could have been submitted taking all the relevant local factors into consideration in relation to the international competition in the field of production and sale of methanol, acetic acid and other bye-products of wood distillation. I am preserving a copy of this report and before writing this paragraph, I re-read the same much to my personal benefit.

Perhaps the most outstanding contribution in the field of chemical industries in India made by Mr. Kapilram Vakil is in the utilisation of salt and the byeproducts of the salt industry. For nearly quarter of a century, he dedicated his life to this branch of heavy chemical industry and undaunted by early failures and difficulties, he achieved a degree of success for which no more monuments are required than the Dhrangadhra Alkali Works and the Tata Chemicals at Mithapur. There was a time when table-salt was being imported from such far off places as Spain and England. Mr. Kapilram Vakil made up his mind that the salt industry should be established in India and started his first manufacture at Kharagoda. The success of Kharagoda enterprise encouraged others and now, a dozen or more similar companies are working successfully. But it was the basic work of Mr. Kapilram Vakil that led to this satisfactory development. Manufacture of magnesium chloride from the salt bitterns at Kharagoda and elsewhere must go to the credit of Mr. Vakil as also the manufacture of bromine from sea water. It will not be an exaggeration to state that Mr. Kapilram Vakil is the father of the salt industry in India.

The love and respect in which Mr. Kapilram Vakil was held by his own staff of officers and men can be proved by the following two extracts from the address presented to him on 28th May 1943 on the occasion of his sixtieth birthday:

> "Some of us present here recall that when you came here seventeen years ago, this place was a veritable desert over-run by cactus bushes and infested by reptiles. In less than two decades, with the encouragement from the Baroda State and the enterprise of the House of Tatas, you have transformed the desert into a modern industrial town where hundreds of people to-day earn their daily bread ..."
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> "In the works at Mithapur, we see to-day the culmination of your work extending over the best part of your life. This could not have been achieved had it not been for the breadth of vision, boldness of conception, tenacity of purpose and untiring energy which you have displayed and which should be a source of inspiration and an example to all of those who are associated with you ..."

In my own humble way I have been somewhat of a pioneer in the field of development of chemical industries in the State of Mysore. I know from personal experience the hardships that a newcomer has to face and the disappointments he has to put up with. There are moments and situations so heart-breaking that one feels like abandoning the project. Time and again, ideals will have to be revived and the struggle recommenced. We have to swallow our pride and we have to pocket our self-respect. The only thing to do is to summon all the patience and perseverance at our

command once again and try to persuade the powers that be that the industry we are recommending is worthy of all the trouble and is in the best interests of India. Mr. Kapilram Vakil was a hero in this respect. If he was convinced that a particular enterprise was good and worth fighting for, he fought like a Trojan. Even in technical and scientific matters, in committees and other places, he was a very tough man to get on with because he was very staunch and unrelenting when he was fighting for an idea which he believed was true. He was very strict and austere in committees but immediately afterwards at the lunch table, his sweet smile would await you and one would feel the warmth of his human qualities. That was my experience. I am sure there are hundreds who would confirm this estimate of him.

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# OBITUARY

## SIR UPENDRANATH BRAHMACHARI, Kt., M.A., M.D., Ph.D., F.R.A.S.B., F.N.I.

*(1873—1946)*

WITH the death on February 6, 1946, at his Calcutta residence, at the age of 73, of Doctor Sir Upendranath Brahmachari, Indian medical world has lost its doyen, one who will long be regarded as one of the most versatile and colourful personalities of modern scientific medicine in India. When Chemotherapy, which first originated with Erhlich in Germany (1908), did not even make its far-reaching influence felt in many progressive Western countries, Brahmachari's imagination and initiative attracted him to this most fruitful branch of Pharmacotherapeutics, and through patient and indefatigable work with almost primitive laboratory facilities at his disposal, he succeeded in discovering a specific (Urea Stibamine) for Kala-azar (*Visceral Leishmaniasis*), which not only saved millions of lives in his own country but also in many areas in the Near and Far East where the fell disease played havoc with human lives (mortality rate, including complicated cases, was recorded as 99 per cent. Following discovery of Urea Stibamine and other specifics, it is stated to be reduced to 1 to 2 per cent.).

Upendranath was the son of late Dr. Nilmoni Brahmachari, a medical practitioner of Jamalpur (District Monghyr), where he was born on December 19, 1873. Early during school career, young Brahmachari showed intelligence and capability of a high order. Following a brilliant career at the school, he joined the Hooghly College from where he took his B.A. Degree with Honours in Mathematics. Then he enrolled himself as a post-graduate student in the Presidency College, Calcutta, and from there took his M.A. Degree in Chemistry obtaining a first class. Here came a turning point in his career. His father, who was a medical practitioner, insisted that his son should go in for Medicine, while he himself desired to follow up the academical line, where his knowledge of chemistry and mathematics would stand him in good stead and enable him to probe into newer fields of knowledge. It was fortunate that the father prevailed, and young Brahmachari ultimately joined the Calcutta Medical College. He passed the L.M.S. (1898), and M.B. (1899) examinations standing first both in Medicine and Surgery. He then joined the Bengal Medical Service and was posted at the Mitford Hospital, Dacca, where, within a comparatively short time, he built up a wide practice and though still young, made a name for himself as a physician of great merit. In spite of his growing popularity and the ever-increasing demand made on his time by patients, he managed to keep his academic activities alive. In 1902, he obtained his M.D., a rare achievement in those days, and within the next two years, secured the PH.D. Degree by submitting a thesis on "Studies in Hemolysis", which remains even to-day a first-class study of the physiological and physico-chemical properties of the Red Blood Corpuscles. In the early part of this century, there was probably no other medical graduate in India who combined in himself a Science Doctorate with a Medical Doctorate.

In 1905, Brahmachari came to the Campbell Medical School, Calcutta, as Teacher of Medicine and remained in this Institution until 1923. From 1923 to 1927, he became the Additional Physician to the Calcutta Medical College Hospitals,—the first non-I.M.S. physician to be so honoured—and after retirement, took up the honorary post of Professor of Tropical Medicine at the Carmichael Medical College, and Professor of Biochemistry at the Calcutta University, which duties he continued to perform until his death.

Brahmachari's most important work, and for which he is so universally known (discovery of Urea Stibamine), was done while he was associated with the Campbell Medical School. Gifted with a keen, inquisitive and analytical mind, he did not fail to take early note of the difference between the two disease entities—Malaria and Kala-azar—which were usually confused in those days for want of laboratory and microscopic data. He was impressed with the fact that while quinine would afford relief in cases of malaria, it would not touch kala-azar cases, who slowly but surely succumbed in spite of the best treatment that could be given to them at that time. The only measure which afforded some promise of relief was the administration of antimony salts in the form of sodium or potassium antimonyl tartrate. Even this was far from satisfactory as the treatment had often to be unduly prolonged without concomitant successful results.

With a grant from the Indian Research Fund Association, Brahmachari got together a young band of organic chemists from the Calcutta

University and started work on the chemotherapy of Kala-azar with antimony compounds. From his clinical observations, he was decided in his mind as to the curative value of antimony in this infection but felt that the dosage administered was not enough. Unless the toxicity of the antimony salt could be reduced, an increase in effective dosage would not be possible. From an analogy of the value of the corresponding organic arsenic compound ('Arsacetin' and 'Atoxyl') in the treatment of certain protozoal diseases and from the more or less successful use of acetyl compound of antimony (Stibacetin, Stibenyl) in the treatment of kala-azar and other forms of leishmaniasis (by Caronia, Spagnoli, Von Heyden, etc.), Brahmachari concentrated his attention on 'Stibenyl' and similar aromatic antimonials. Mason-Bahr had already reported good results with Stibenyl but Mackie and others reported unsatisfactory results. It is not exactly known how Brahmachari conceived the idea of combining stibenylic acid with urea, but it is possible that he might have been trying to get an antimony compound suitable for intramuscular administration and was guided by the fact that combination with urea of an irritant aromatic antimonial would reduce local pain and discomfort, in the same manner as Quinine and Urea injections. In any event, as a result of this combination, Urea stibamine was produced, which even during early trials (1920-22), showed clear promise as a very potent remedy in the treatment of kala-azar. The chemical composition of Urea Stibamine is still undecided. It was originally reported to be a substance composed of urea and *para*-aminophenylstibonic acid with the empirical formula $C_7H_{10}O_4N_2Sb$. The "effective active principle" in this compound was claimed by some to be a di-substituted urea, *S*-diphenyl-carbamide-4 : 4 distibonic acid. Whatever be its chemical entity, laboratory and clinical trials all over Assam and other endemic areas indicated in no uncertain terms the remarkable efficacy of the drug—an efficacy corroborated by many workers, chief amongst whom may be mentioned Shrott and Christophers.

Brahmachari's name is so intimately identified with the discovery of Urea Stibamine that his other contributions as a clinician and as a chemotherapeutist are largely eclipsed and apt to be forgotten. As a diagnostician, he was held in high esteem by his contemporaries and he was the first to describe a new form of Cutaneous Leishmaniasis which is still listed as '*Dermal Leishmaniasis*' (Brahmachari) in all treatises on tropical medicine. In the domain of antimalarial chemotherapy, he left significant contributions through his studies of the quinoline and acidic compounds.

Fame, fortune and honour came to Dr. Brahmachari from every quarter—from his *Alma Mater*, the Calcutta University, from the Government, under whom he served and from almost all the scientific and academic bodies functioning in India. He was the recipient of the Griffith Memorial Prize, the Coates Medal, the Minto Medal, the Sir William Jones Medal and the Berkley Medal for his research contributions. He was elected President of the Medical and Veterinary Section of the Indian Science Congress in 1930 and General President at the Baroda Session of the Congress in 1936. In the Jubilee Session of the Indian Science Congress, when distinguished foreign delegates visited India, he again shouldered the responsibility of the Presidentship of the Medical Section. He was a President of the Royal Asiatic Society of Bengal and a Foundation Fellow of the National Institute of Science of India. He was one of the seniormost Fellows of the Calcutta University and was intimately connected with all its activities. Space will not permit a mention of the many other organisations with which he was associated. He was easily one of the most outstanding and towering personalities in the Indian scientific world and he fittingly played his part wherever he moved. He was first made a Rai Bahadur and was later Knighted in 1936.

Dr. Brahmachari was the author of several books and also contributed liberally to the scientific journals of his time both in India and abroad. His first book, *Kala-Azar—Its Treatment* (Butterworth & Co., Calcutta), came out in 1917. This went through several editions. In Carl Mense's *Handbuch der Tropenkrankheiten*, Vol. IV, he contributed a masterly chapter on Kala-azar in 1926. Subsequently, he published a fuller account in 1928 in *Treatise on Kala-Azar* (John Bale Sons & Danielson, Ltd., London). His *Gleanings from My Researches* in two volumes appeared in 1940 and forms stimulating reading to all workers in the field of chemotherapy. His active mind would not permit him to rest on the laurels already achieved. He was contemplating writing another book when failing health preparatory to his death prevented him from the effort.

The lifework of Brahmachari as one of the pioneers of chemotherapeutic research in India and probably also in the East will long remain a brilliant inspiration to all of those who are privileged to carry on endeavours in his field of choice; we owe more to him than to anybody else for putting medical research in India on the map of the world.

B. MUKERJI.

# LETTERS TO THE EDITOR



## ON A CURIOUS SOLUTION OF RELATIVISTIC FIELD EQUATIONS

In the course of a recent investigation we have come across a metric which is Riemannian (non-flat) by virtue of the condition,

$$B_{\epsilon\mu\nu\sigma} \neq 0,$$

which satisfies the field equations of gravitation for empty space, *viz.*,

$$G_{\mu\nu} = 0.$$

which is free from similarities and for which the pseudo-tensor density of gravitational energy and momentum is *everywhere* zero, that is,

$$t_\mu^\nu = 0.$$

The metric is

$ds^2 = -dx^2(1+kt)^p - dy^2(1+kt)^q - dz^2(1+kt)^r + dt^2$, where $k$ is an arbitrary constant and $p$, $q$, $r$ are constants subject to

$$p + q + r = 2, pq + qr + rp = 0.$$

It follows that if $p$, $q$, $r$ are real they must lie between 2 and $-2/3$. If $q = r = 0$, the space-time becomes flat. One particular case of interest is $p = -2/3$, $q = r = 4/3$. It is not correct to say that the metric gives a flat space-time when $t = 0$ because the surviving components of the curvature tensor, $B_{4114}$, $B_{4224}$, etc., are non-zero even when $t = 0$.

Either as a cosmological model, or as a transitional model for a finite portion of space, that is something like a vacuum pocket into which matter is rushing from the surrounding portions of an extra-galactic nebula, the asymmetric field given by the above metric deserves consideration. We have investigated all possible line-elements for which $g_{\mu\nu} = 0$, $\mu \neq \nu$ and the conditions laid down in the beginning are satisfied. The most general solution is one in which the four surviving $g$'s are certain functions of one and the same variable. But the above solution is the only one we have found worth reporting. In an investigation like this, while there is the danger of discovering a solution of no physical interest, after much mathematical ado, one cannot at the same time overlook the possibility of discovering new gravitational situations.

V. V. Narlikar.
K. R. Karmarkar.

Benares Hindu University,
*February* 8, 1946.

## BANDS IN THE COPPER ARC

Widely spaced double-headed bands between λ 6600 to λ5800 and a large number of weak bands from λ 5350 to λ 5200 are well known to occur in the ordinary copper arc in air and in flame spectra of copper salts. Although the electronic transition is not yet established, they are attributed to the CuO molecule and are observed intensely in a copper arc in an atmosphere of oxygen. In an investigation on these bands it has been observed that there is a group of three red-degraded bands (not recorded previously) appearing rather faintly in the ordinary copper arc in air, and considerably enhanced in the copper arc in high pressure oxygen. The electrodes used are of the Hilger

H.S. brand. The wavelengths of the bands are: 4488·14 (1), λ 4487·48 (3), λ 4487·04 (4) A.U. Experimental observations indicate that these bands are also due to the CuO molecule.

Andhra University,
Guntur, V. RAMAKRISHNA RAO.
*February* 16, 1946.

1. Loomis, F. W., and Watson, P. R., 1935, **48**, 280. 2. Pearse and Gaydon, *The Identification of Molecular Spectra*, p. 109.

## ULTRA-VIOLET BANDS OF MERCURY IODIDE

IN a previous letter[1] three new systems of bands between λ 2550-λ 2300 ascribed to the diatomic mercury iodide molecule have been reported. Photographs of the band spectra below λ 2300 have since been taken using ultra-violet sensitised and Special Ilford QIII plates. The G. & H systems[2] reported briefly by Prilheshejewa[3] have been obtained and measured under high dispersion. About forty band-heads are recorded in the G system, (λ 2250-2165). Analysis of the complex structure of this system has revealed the existence of three distinct *V'* progressions. The G & H systems as well as the $F_1$, $F_2$, $F_3$ systems are found to have the same lower state, presumably $^2\Sigma$, as the C and D systems analysed previously.[2] A detailed discussion of the analysis of these bands will be presented elsewhere.

V. RAMAKRISHNA RAO.
K. R. RAO.

Andhra University,
Guntur,
*March* 11, 1946.

1. V. Ramakrishna Rao and K. R. Rao, *Curr. Sci.*, 1945, **14**, 319. 2. Rao, Sastry and Krishna Murty, *Ind. Jour. Phy.*, 1944, **18**, 323. 3. Prilheshejewa, *Phys. Z. Sowjet.*, 1932, **1**, 189.

## PRINCIPLE OF CONSERVATION OF ENTROPY AND EQUATIONS FOR THE REVERSIBLE SATURATION ADIABATS

THE equations for the adiabatic ascent of saturated air in the atmosphere are derived by treating the ascending air and the resulting products of condensation—water (above 273°A) and ice below 273° A)—as a closed system and applying the well-known principle of conservation of entropy for the changes taking place in the system. Three distinct stages are usually considered during the ascent, *viz.*,

(i) *The Rain Stage* ($T > 273°$ A) during which the product of condensation resulting from the ascent is water;
(ii) *The Hail Stage* ($T = 273°$ A) during which all the liquid water is transformed into solid ice;
(iii) *The Snow Stage* ($T < 273°$ A) during which the water vapour passes over directly into the solid state (sublimation).

It is obvious that if we write down the expressions for the entropy of the system in each of the three cases mentioned above, it should have the same value.

In his treatment of the problem in the second edition of his book on "Physical and Dynamical Meteorology", D. Brunt[1] starts with the principle of conservation of entropy, but the connection between his equation for the rain stage on the one hand and snow stage on the other is not quite clear. It might be mentioned that if we try to solve the equation for the snow-stage given by Brunt by substituting the entropy value used during the rain stage, it will lead to totally erroneous values despite the apparent similarity of the two equations.

This apparent contradiction can be got over if in developing the expressions for the entropy of the three phases of water we choose the temperature corresponding to the zero of the entropy scale *below* the freezing point of water in all cases and also postulate explicitly that below $T_0 = 273°$ A the liquid phase is absent. In this case the following expressions for the entropy can be easily developed:—

$\phi_1$ = Entropy of 1 gram of dry air at temperature T and pressure $(p - e)$

$= c_p \log T - A R \log (p - e)$

$\phi_2$ = Entropy of $z$ grams of ice at temperature T ( $< T_0$) $= z\, c_i \log T$

$\phi_3$ = Entropy of $y$ grams of water at temperature T ( $> T_0$)

$$= y\, c_i \log T_0 + \frac{L_e\, y}{T_0} + y\, c \log \frac{T}{T_0}$$

$$= y\,(c_i - c) \log T_0 + y c \log T + \frac{L_e\, y}{T_0}$$

$\phi_4$ = Entropy of $x$ grams of vapour at temperature T ($\leqslant T_0$) in equilibrium with ice

$$= x\, c_i \log T + \frac{L_i\, x}{T}$$

$\phi_5$ = Entropy of $x$ grams of vapour at temperature T ($\geqslant T_0$) in equilibrium with water

$$= x\,(c_i - c) \log T_0 + xc \log T + \frac{L_e\, x}{T_0} + \frac{L_T\, x}{T}$$

(The symbols have the same meaning as in Brunt's book.)

If we consider the adiabatic ascent of a sample of saturated air in which 1 gram of dry air is mixed with grams of water vapour, we can derive the following equations:—

(*a*) *Rain Stage* ($T > T_0$).

$$\xi = x + y$$

$$\phi = \phi_1 + \phi_3 + \phi_5 \qquad (1)$$

$$= (c_p + \xi c) \log T - A R \log (p - e) + \frac{L_T\, x}{T} + \left[\xi\,(c_i - c) \log T_0 + \frac{L_e\, \xi}{T_0}\right]$$

$$= \text{Constant.}$$

Compared with the entropy equation given by Brunt we see that the expression within the double brackets (which is a constant for a given value of $\xi$) occurs as an additional term.

(*b*) *Hail Stage* ($T = T_0$).

For the *beginning* of the hail stage, we have:—

$$\phi = \phi_1 + \phi_2 + \phi_5 \quad (2)$$
$$= (c_p + \xi c_l) \log T_0 - A R \log (p_1 - e_0) + \frac{L_{T_0} x_1}{T_0} + \frac{L_e \xi}{T_0}$$
$$= \text{Constant.}$$

For the *end* of the hail stage, we have :—

$$\phi = \phi_1 + \phi_2 + \phi_4 \quad (3)$$
$$= (c_p + \xi c_l) \log T_0 - A R \log (p_2 - e_0) + \frac{L_f x_2}{T_0}$$
$$= \text{Constant.}$$

Hence we have:—

$$- A R \log (p_1 - e_0) + \frac{L_{T_0} x_1}{T_0} + \frac{L_e \xi}{T_0} \quad (4)$$
$$= - A R \log (p_2 - e_0) + \frac{L_f x_2}{T_0}$$

This is in agreement with Brunt's equation.

(c) *Snow Stage* ($T < T_0$)

$$\xi = x + z$$
$$\phi = \phi_1 + \phi_2 + \phi_4 \quad (5)$$
$$= (c_p + \xi c_l) \log T - A R \log (p - e) + \frac{L_f x}{T}$$
$$= \text{Constant.}$$

This equation is the same as that given by Brunt for the snow stage. In equations (1), (2), (3) and (5), the constant ($\phi$) has the same value. It might be mentioned that the expression, $\xi (c_l - c) \log T_0 + \frac{L_e \xi}{T_0}$ represents the magnitude by which the value of the constant has to be altered when we come to the snow stage if we use Brunt's equation for the rain stage.

Meteorological Office, Upper Air Section, Poona 5, *February* 16, 1946.

R. ANANTHAKRISHNAN.
S. YEGNANARAYANAN.

1. Brunt, D., *Physical and Dynamical Meteorology*, 1939, 59–60.

## A TORNADO CLOUD AT MADRAS

A TORNADO cloud was observed towards the southeast of Madras on the 8th of October at 12-45 p.m. As there is no record of such a cloud having been observed before in this part of the country, a description of the meteorological conditions accompanying it and a sketch of the observed cloud were considered to be of sufficient interest to merit publication. It was unfortunate that a photograph of the cloud could not be taken for want of equipment at the time.

The phenomenon was seen from the Observatory at Meenambakkam which is on the southern outskirts of Madras. It seemed to be more than five miles away to the southeast of the Observatory and was probably over the sea. Earlier, the sky was about 7/10 covered with cumulo-nimbus clouds. A belt of sky, about 10 degrees above the horizon, was practically clear, except for distant whitish cumulus clouds. The base of the cumulo-nimbus clouds stood out in clear relief against this background. A funnel-shaped protrusion was observed in one place along this base line at 12-45 hours I.S.T.* It extended up to about 5 degrees above the horizon as in Fig. 1 and

FIG. 1. The tornado cloud at 12-45 p.m.

soon became bent near the lower end (12-50). The part below the bend decayed rapidly, while the part above gradually shrank into the shape of a turbulent cone (12-55). The whole protrusion vanished suddenly at 13-00 hours.

Graphs of the surface temperature and humidity on the 7th, 8th and 9th October as recorded by the self-recording instruments at the Observatory are reproduced in Figs. 2 and 3.

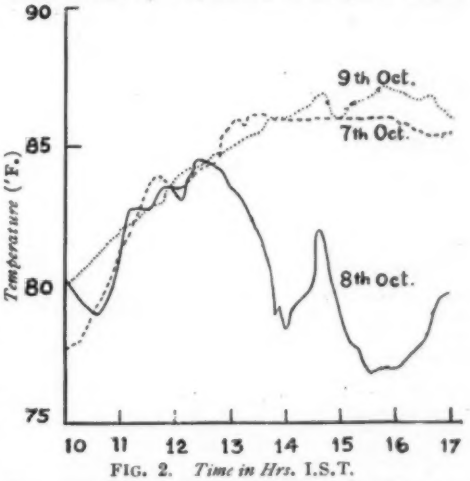


FIG. 2. *Time in Hrs.* I.S.T.

The temperature curve for the 8th shows a sudden fall from about 12-40 hours onwards, quite unlike what happened on the previous and following days. The relative humidity rose sharply on the 8th from about 12-30 hours in striking contrast with that on the other days. The upper winds at Madras, which were easterly even till the evening of the 7th, became northeasterly by 03-00 hours of the 8th and backed almost to the north by 09-00 hours. The winds continued to be northerly thereafter, The wind speed at all levels was, how-

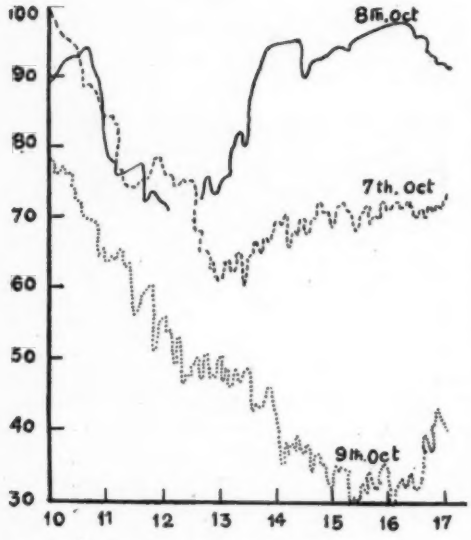


FIG. 3 *Time in Hrs.* I.S.T.

ever, low and did not exceed 15-20 m.p.h. on the 8th. The upper air temperatures, as determined by aeroplane ascents made at dawn, showed a fall by 2-4° F. at all levels on the 8th from the values on the previous day. There was no rain on the 7th and 9th, while on the 8th 34 cents of rain occurred at the Observatory during the period 13-40–15-30 hrs. The synoptic charts disclosed a general fall of minimum temperature up to about 300 miles to the northwest of Madras on the 7th, almost up to Madras on the 8th and practically over the whole of eastern half of the Peninsula on the 9th. There were no major disturbances in weather of any kind over land or out to sea.

It may be inferred, in view of the above facts, that the appearance of the tornado cloud was associated with the incursion of cold northerly air at Madras on the morning of the 8th, in the first flush of the northeast monsoon. The temperature contrast was probably small at the time and the tornado cloud may not have had enough supply of energy to reach down to the surface level. Even though the temperature fell later on to a fairly low value, the contrast seems to have been actually less marked, as there was not much of turbulence to be seen in the cloud.

One noteworthy feature of the tornado cloud was the pointing of its tapering end towards the south. This is what one should expect because of the spin of the earth.[1]

Meteorological Office,
St. Thomas Mount,
Madras, D. VENKATESWARA RAO.
*November* 20, 1945.

* The hours given in this article refer to the War Time.

1. Sir Gilbert Walker, "*Some Problems of Indian Meteorology*," *Halley Lecture*, May 1929.

## A NEW METHOD OF GROWING *ASP. ORYZAE*

IN the course of our studies of the factors which influence the formation of enzymes, it became imperative to evolve a reproducible technique of culturing *Aspergillus oryzæ*. In addition to the nutrients and the growth factors, the fungus requires a moist 'bed' or 'soil' with a texture or 'tilth' for facilitating free and adequate access of air which is essential for the growth of the organism. In our earlier studies weighed amounts of acid digested asbestos fibre moisted with definite quantities of the nutrients were employed.[1] The large number of weighings thus involved, became laborious and it was not possible to secure uniformity of 'tilth' due to differences in the packing and spreading of the fibre in the reaction flask.

It was of interest to experiment with filter paper as a substitute for asbestos; it was expected to possess several obvious advantages; its readier absorption and retention of the nutrients; the case and rapidity with which given quantities of paper could be dispensed for experiments, and the facility and certainty of securing reasonable uniformity of 'tilth' and surface in the experiments. Test tubes (155 mm.× 15 mm.) slantingly placed as in the work on antibiotics in our laboratory,[2] served to replace the conical flasks employed in our previous studies; this innovation served to simplify and reduce the cost of the experiments.

### EXPERIMENTAL

64 Square centimeters (80 mm.× 80 mm.) of Whatman's filter paper No. 1 were cut, folded and introduced into the test tubes. After plugging with cotton, the tubes were sterilised at 20 lbs. for an hour. The nutrient solution, together with supplements if any, is then introduced to moisten the filter paper which absorbs about 1·5 c.c. of the liquid; water is added to make up the volume to 3 c.c. in all the tubes and for allowing for evaporation during incubation. The fungus spore suspension is prepared and added to each tube. After incubation for four days at 28° C., the fungus mat along with filter paper is disintegrated, toluenated water (5 c.c.) added, autolysed at 37° C. for 24 hours, filtered, washed and the enzyme extract made up to 100 c.c.

The composition of the media is given below in Table I.

TABLE I

*Composition of the nutrient media*

| Constituents | I | II | III | IV | V |
|---|---|---|---|---|---|
| *Bran extract (c.c.) | 1·0 | .. | 1·0 | 1·0 | 1·0 |
| Starch (c.c.) | 1·0 | 1·0 | .. | 1·0 | 1·0 |
| † Peptone (c.c.) | 0·5 | 0·5 | 0·5 | .. | 0·5 |
| Salts (c.c.) | 0·5 | 0·5 | 0·5 | 0·5 | .. |
| Water (c.c.) | .. | 1·0 | 1·0 | 0·5 | 0·5 |
| Total volume | 3·0 | 3·0 | 3·0 | 3·0 | 3·0 |

*Papain digest of wheat-bran 2 mg. /c.c.

†Difco Bacto-peptone 1·567 mg. N/c.c.

The diastatic activity of the extracts is determined as described previously.[3] The results are given below :—

TABLE II

*Total Activity of the Enzyme Extracts in Linter Units*

| I (Full) | II (–bran) | III (–starch) | IV (–peptone) | V (–salts) |
|---|---|---|---|---|
| 197·1 | 63·90 | 77·98 | 136·5 | 111·7 |
| 205·5 | 79·98 | 86·22 | 138·8 | 106·3 |

The results indicate that the method gives reasonably consistent and reproducible results.

M. R. RAGHAVENDRA RAO.
M. SREENIVASAYA.
Section of Fermentation Technology,
Indian Institute of Science,
Bangalore,
*March* 9, 1946.

1. Bindal, A. N., and Sreenivasaya, M., *J.S.I.R.*, 1945, **3**, 386. 2. Rammohan, R. Ramachandra Rao, T. N. and Sreenivasaya, M., *Ibid.*, 1945, **4**, 375. 3. Bindal, A. N., and Sreenvasaya, M., *Ibid.*, 1944, **2**, 245.

## COAGULATION STUDIES OF CRYPTOSTEGIA LATEX

THE properties of the latex changed according to the seasonal changes and hence wide variations were observed in the percentages of dry rubber, non-rubber constituents and pH values. The latex was found to be stable between a pH range of 3·5 to 7·5. Beyond this range it exhibited curdling effect. Investigations of the coagulating properties of various chemicals were carried out in the Experimental Station at Okhla since 1943. Acids and alkalies could not produce coagulation. Common salt in sufficient concentrations as to saturate the serum of the latex effected coagulation. It was found that small quantities of common salt, formalin, or tannic acid, if mixed with the latex and heated to 85° C. for ten minutes could coagulate the latex. It has been reported that hot water between 30 and 90° C., if added in volumes about 7 times the volume of the latex, could produce efficient coagulation and the quality of the rubber produced by this method to be good. Though the method looks simple, in factory practice the procedure is inconvenient, as for example, if there is a crop of about 500 gallons of latex, 3,500 gallons of hot water at 80° C. is to be kept ready for coagulation.

It has now been found that soap is an excellent coagulant and can be used as soap solution of 0·5 per cent. strength, the pH being adjusted to 7·5 by the addition of any alkali. The volume of the coagulant required depends on the D.R.C. of the latex and in most cases it does not exceed 35 per cent. of the volume of the latex. It was found that 2½ lbs. of soap could coagulate about 100 lbs. of rubber. The samples of rubber prepared by the above process after compounding and vulcanizing were tested and found to be 85 to 90 per cent. as good as the best hevea rubber.

As certain colloidal dispersions are able to produce coagulation, investigations were continued to find out the effect of mixing Cryptostegia latex with hevea latex. A 100 c.c. of fresh Cryptostegia latex of D.R.C. 7 per cent. was kept in a beaker and ammonia preserved 30 per cent. hevea latex of alkalinity 0·6 per cent. was added in drops from a burette. After the addition of 7 c.c., it was found that there was complete coagulation of the rubber of Cryptostegia and hevea latices. The serum was brownish in colour and was absolutely free from rubber. The pH was observed to be 7·5. It was found that the serum obtained from hevea latex after acid coagulation did not coagulate Cryptostegia latex even after adjustment of pH to 7·5, probably because the acid had already precipitated the proteins of the serum of hevea latex. Therefore, to confirm whether it was the colloidal proteins or the rubber molecule that was responsible for the mutual coagulation, the serum of hevea latex obtained after driving off the ammonia and subsequent coagulation by bacterial activity, was added to 100 c.c. of Cryptostegia latex of the same D.R.C. It was found that 5 c.c. of serum was sufficient to produce effective coagulation of the Cryptostegia latex, if the pH was adjusted to 7·5 by the addition of a drop or two of ammonia solution. The serum extracted from frozen latex also behaved in the same way. The above experiments were then repeated with Cryptostegia latex cream, and it was observed that the quantities of ammonia preserved hevea latex and also of the serum obtained by bacterial activity required for coagulating the cream were smaller than those required for the normal Cryptostegia latex, for in the process of creaming a large percentage of colloidal proteins had been eliminated. This definitely proves that the coagulation of latices is brought about by the mutual coagulating property of their protective colloids, mostly proteins, and it supports Vernet's view that coagulation is caused by protein precipitation. By this method, the volume of the coagulant required is also reduced from 35 per cent. soap solution to 7 per cent. of hevea latex. Since there is complete precipitation, the percenage of non-rubber constituents are also reduced. The coagulum formed is found to be harder than when Cryptostegia alone is coagulated and hence it is easier to pass through the rollers to be converted into sheets. The discovery of the mutual coagulating property of the latices is of great technical importance in so far as a harder coagulum is obtained and also the introduction of chemicals are avoided.

I express my thanks to Mr. J. P. Anderson, Controller of Rubber, for the facilities given to me to continue the researches and also for th permission to publish these results.

A. K. M. PILLAI.
Cryptostegia Experimental Station,
Government of India,
Muttra,
*October* 9, 1945.

## THE EFFECT OF COLCHICINE ON RICE

COLCHICINE is a deadly poisonous drug prepared from parts of *Colchicum autumnale* (N.O. Liliaceæ) and is being extensively used in inducing gross genetic changes including polyploidy in various plants by many investigators. The present note deals with the result of the experiment carried by us to find out the effect of colchicine treatment on the growth and development of rice plant and also to observe whether any or all of the changed characters are transmitted to the subsequent generations Dhairal aus paddy, an improved strain of the will be published elsewhere, but a few important results are given below for ready reference.

Treatment of rice seeds and seedlings of Dhairal aus paddy, an improved strain of the Bengal Agricultural Department, and their progenies in subsequent years by colchicine, shows marked response. The treated seeds show on germination swollen appearance with shortened and thickened plumule, while the growth of the radicle is appreciably slowed down with increased concentration of the colchicine solution (Fig. 1). This swollenness decreases increasingly with the decrease of colchicine concentration and also with the decrease in the period of treatment. In the case of seedling treatment both plumule and radicle swell markedly. In higher concentration of the colchicine solution the survival of the seedlings is meagre.

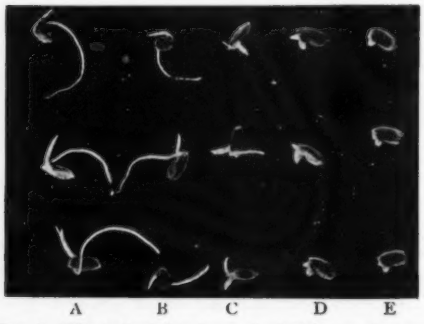


FIG. 1. Effect of varying doses of colchicine on rice seeds for 48 hours, showing the gradual swollen appearance of the plumule with increased concentrations of colchicine solution; while the growth of the radicle is gradually slowed down.

A-Control; B—.05%; C—.1%; D—.5%; E—.1·0 %

A definite critical period for tillering from the 5th to the 7th week after sowing has been observed in treated and untreated progenies in 1944, while in control the tiller number goes on increasing. Treated progenies are the descendants of the 50 per cent. of seeds collected from the selected plants arisen from colchicine treated seeds. They are again treated in succeeding generations with the same doses of colchicine solution; while the untreated progenies are the descendants of the other 50 per cent. of seeds, without further treatment with the colchicine solution in succeeding generations. In 1942 and in 1943 no such critical period for tillering was observed. Generally in aus paddy there is no definite critical period of tillering. With the maturation of the early tillers, other tillers (late tillers) crop out from the base of the plants. In our experiment a cumulative effect has been obtained by colchicine treatment as evidenced by a distinct critical period of tillering already mentioned. Engledow (1923, 1924 and 1926) in his wheat experiment stresses the importance of early tiller formation as an index of high-yielding capacity in a variety.

In 1943 a clean tetraploid plant was also obtained in $LP_1L^*$ but the plant failed to set grains. In 1944 in $EP_1EP_1E^{**}$ diploid and tetraploid chimeras having longer ears and bigger grains, were obtained (Figs. 2 and 3). It may be expected that in the next generation a clean tetraploid may arise from the grains collected from the tetraploid chimeras. Blakeslee (1939) observed in *Datura stramonium*, grown from a seed treated with colchicine both 2*n*

FIG. 2. Ears of rice from control plant (*left*) and from tetraploid chimera (*right*). Note longer size of ears and of flag leaf in latter.

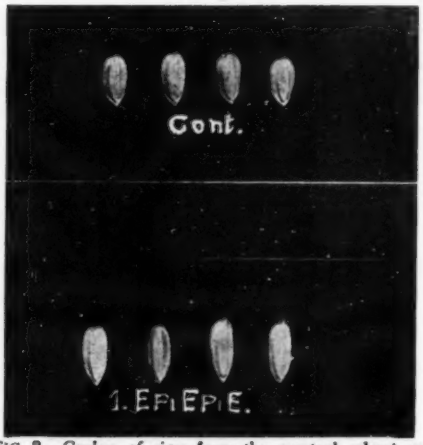


FIG. 3. Grains of rice from the control plant and from the tetraploid chimera. Note bigger grains in latter.

and 4*n* branches. This is possible when seeds are soaked in colchicine solutions for varying lengths of time different cells in the epicotyl may be affected differently. Consequently the plant that develops may be a chimera of one sort or another (Bergner *et al.*, 1940).

The size of stomata has been measured from the control as well as from the treated and untreated progenies. No increase in size of stomata has been observed. They are more or less of the same size as that of control; while the larger size of pollen grains has been observed in treated progenies. Blakslee (1939) states that the larger size of stomata is characteristic of tetraploids but holds strictly only for comparable leaves. Stomata size was found a reliable criterion when the stomata were taken from the floral bracts of females.

Awn develops on one or two apical spikelets on the panicle of the tetraploid tillers in $EP_1EP_1E$; the other spikelets remaining awnless. Of course, the awned spikelets are sterile. Sethi *et al.* (1937) point out that crowding of plants tends to increase awn development irrespective of nutrition, as when adequate nutrition was supplied by heavy manuring the relation between the crowding and awnedness remained unaltered. But, here the case is different. Dhairal is an awnless strain of aus paddy. The occurrence of awn on the spikelet of tetraploid tillers is due to the increased vigour of that particular tiller occasioned by the cumulative effect of colchicine solution. Copeland (1924) observes: "Awns seem at least sometimes to be associated with general vigour perhaps in that they were a character of the ancestral wild rice and the breeder who would get rid of them might conceivably do this through the elimination of vigour. It is hardly questionable that as a general average awned rices are heavier producer than awnless varieties." Hector (1934) states that vigour may sometimes be associated with awns, but there is no definite correlation between awns and yield. In fact, most of the high-yielding Bengal rices belong to the awnless group.

One sheathed ear is noticed in $EP_1EP_1E$ while sheathed ear is completely absent in Dhairal. All the spikelets of the sheathed ear are sterile. This is due to the expansion of the leaf-sheath which enclose the ear.

Marked rise in grain yield has been observed in $EP_1EP_1E$ and in $LP_1L$ where the number of fertile grains is also appreciably increased together with the increased length of ears. The results are given in the accompanying table.

| Treatment | Mean of 18 plants | | |
|---|---|---|---|
| | Length of ears cm. | Dry weight of grain. gm. | Number of fertile grain. |
| Control | 16·4 | 6·68 | 274·9 |
| $EP_1EP_1E$ | 19·4 | 9·47 | 366·8 |
| $LP_1L$ | 17·6 | 8·87 | 377·2 |

* $LP_1L$–$F_2$ progeny of L which is seedling treatment in ·5 per cent. of colchicine solution for 2 hours, it is again treated in succeeding generations with the same doses of colchicine solution.

** $EP_1EP_1E$–$F_2$ progeny of E which is seed treatment in 1 per cent. of colchicine solution for 48 hours, it is again treated in succeeding generations with the same doses of colchicine solution.

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Central Agricultural Res. Station,
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*January* 29, 1946.

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## THE CUCURBITACEOUS STEM

There appears to be some lack of clarity in respect of the internal structure of the axis of the *Cucurbitaceæ* which is a very common material employed for class-work as a type to demonstrate bicollateral vascular bundles. In almost all the genera, a hypodermal collenchyma band and a deeper-seated sclerenchyma band are a common feature. In *Cucurbita maxima*, Duch., whose stem was examined critically, there were seen these two bands as also two concentric rings of vascular bundles, about five in each ring (Fig. A). Those in the outer ring are somewhat smaller and placed opposite the engles of the stem. While there could be no doubt as to the cortical nature of the collenchyma, doubt seems to exist regarding the fibrous ring. The parenchyma that comes below the sclerenchymatous ring comes for no description. Solereder (1908) mentions that the sclerenchyma ring is developed in the cortex. In the supplement (Solederer, 1908) it is described as a pericycle. In the form investigated at present (Fig. B), the following tissues are seen:—Single layer of epidermis (Fig. B 1), about five layers of collenchyma (2), about two layers of parenchyma (3, 4), about six layers of sclerenchyma (5), and a broad zone of loosely arranged parenchyma cells (6). Of the two parenchyma layers formed between the collenchyma and sclerenchyma, the lower is regularly arranged and is full of starch grains. Casparian bands are also seen. So it is the endodermis demarcating the inner limit of the cortex which on this interpretation must be said to consist of an outer collenchymatous portion five cells thick and an inner parenchymatous zone, one layer in extent. Obviously, the sclerenchymatous band that is internal to the endodermis must belong to the pericycle, and this has been indicated by some authors (Solereder, 1908; Strassburgher, 1924). If that is so, what is the nature of the broad stretch of parenchyma which intervenes the vascular

cylinder and the sclerenchymatous pericycle? It cannot be the cortex as it is internal to the pericycle which is the outer limit of the vascular cylinder. The suggestion is made that the pericycle in the Cucurbitaceæ is differentiated into two regions, the outer sclerenchymatous and the inner parenchymatous. Heterogeneous pericycles are by no means rare. In herbaceous stems like *Helianthus* we find the pericycle made up of alternate bands of sclerenchyma (Hard-bast) and parenchyma forming a continuous multicellular pericycle ring. In this case, also, it is heterogeneous being made up of sclerenchyma and parenchyma, only instead of being juxtaposed, they are superimposed.

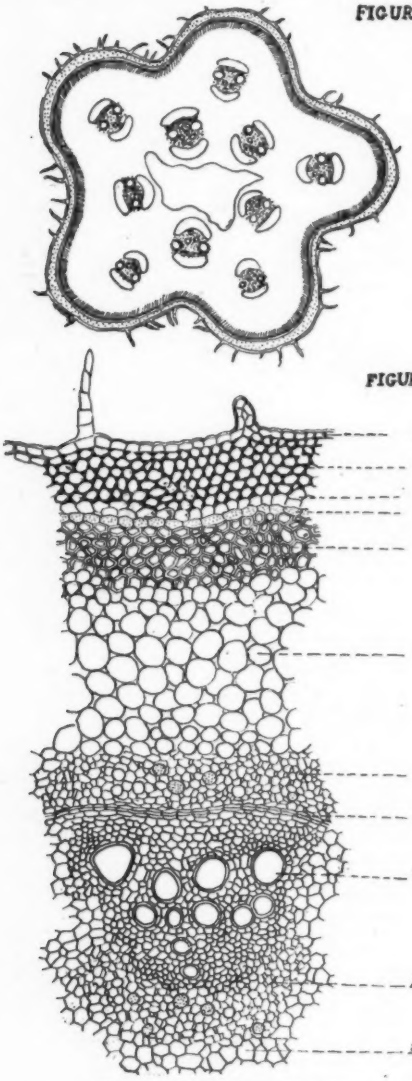


FIG. 1. Cucurbitaceous stem

The Cucurbitaceæ have been of phylogenetic interest from the anatomical point of view. Worsdell (1915) came to the conclusion that the vascular system of the family represented a vestige of a former ancestral scattered system of vascular bundles, such as obtains in Monocotyledons. According to him only two series of rings remain in perfect condition, the rest appearing in the form of rudimentary external phlœm strands, etc. The bi-collateral bundle is, on this basis, a compound structure consisting of the intimate association of two distinct vascular bundles of which the inner has lost its xylem. According to him, therefore, this double ring of vascular bundles is a reduction from a scattered condition. Outside the zone of the two main bundle-rings, but within the sclerotic ring, a few extremely rudimentary phlœm strands were found in some genera. These, according to him, are vestigial. No such vestigial strands were, however, seen in the present material. If this position is accepted, the stretch of parenchyma from the sclerotic ring to the vascular cylinder should be regarded as the ground tissue. In some Monocots, like *Cynodon*, there is a sclerenchymatous ring of pericycle closely attached to which is a ring of small bundles. Internal to this, we find bundles of varying sizes scattered throughout the ground tissue. If Worsdell's view is accepted it implies that where originally bundles were closely approximating to the sclerotic pericycle, there we get ordinary parenchyma devoid of vascular strands. It means that the parenchyma tissue found internal to the sclerenchymatous pericycle must be in the nature of ground tissue. Whatever its nature may be, its presence must be noticed and explained. Without going into the question of phylogeny, on the basis of the structure found in the present day *Cucurbitaceæ*, it seems reasonable to designate the parenchyma as the inner pericycle.

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*February* 1, 1946.

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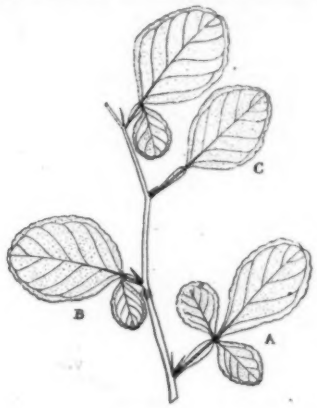
## A NOTE ON THE OCCURRENCE OF UNIFOLIATE LEAVES IN *TRIPHASIA*

*Triphasia* comes from the Greek Triplex (Bailey, 1933). It is a member of the *Rutaceæ*, tribe *Citræ*. According to Gamble (1919), it is found wild and cultivated, apparently introduced from China. It is even popularly called the Chinese Lime (Macmillan, 1935). But Hooker (1873) thinks it is a native of

Southern Concon. It is a mono-typic genus having a single species *Triphasia trifoliata* DC. (= *T. aurantiola* Lour.). Leaves are described as alternate, sessile and trifoliate, the lateral leaflets being smaller than the terminal. While on a botanical tour to the Palni Hills, on the scrub jungly base of the hills, this plant was very commonly met with. The tap-root is very deep and the plant is about 4 to 5 feet in height. An examination of a number of plants revealed that the majority of the leaves of the plants, had unifoliate rather than trifoliate leaves. All stages from the trifoliate to the unifoliate condition were seen in every plant as a rule. No specific region of the plant could be said to show this transition exclusively. It was found all over the plant. The accompanying figure shows a small portion of a plant in




*Triphasia trifoliata*, D.C.

which the leaf *A* shows the trifoliate condition, with the terminal leaflet much bigger than the two lateral leaflets. Leaf *B* shows the bifoliate stage. Leaf *C* shows the Unifoliate condition. The rachis is slightly winged and the joint at its tip is very pronounced. The presence of the joint is the only test by which the leaf is determined to be a compound one with a single leaflet even as in the case of the staminate flowers of a *Cyathium*, where the articulate stamen is the criterion upon which it is considered as an appendage to the pedicel of a naked, one-stamened flower. It may be that this is an another species of *Triphasia* because in *T. trifoliata* the leaves are definitely described as trifoliate. Also the thorns in the species under description are not so prominent as the description for *T. trifoliata* would have it. A more complete examination of the flowers and fruits of which enough could not be got now, would reveal whether or not it is the same species. This will be done as soon as flowers and fruits become available. In the meantime this plant appears to be very suitable for the visual demonstration of the evolution of the unifoliate condition from the trifoliate stage.

We are grateful to Prof. T. S. Raghavan for having brought this to our notice and suggesting relevant literature.

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R. RANGANADHAN.

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Annamalai University,
*February* 1, 1946.

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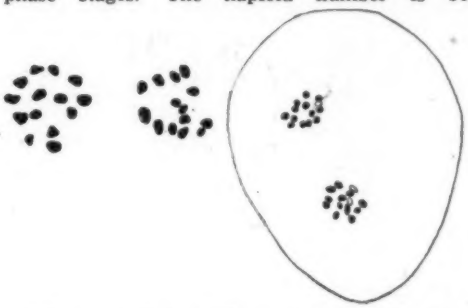
## CHROMOSOME NUMBER IN *CASSIA SOPHERA* LINN.

FOR sometime the writer has been studying the cytology of some species of *Cassia*. Among others *C. sophera* has also been investigated. The haploid chromosome number in this species was determined from temporary aceto-carmine as well as permanent smear preparations of pollen mother-cells at I and II metaphase stages. The haploid number is 14



FIGS. 1–3.—*Cassia Sophera*. FIGS. 1 and 2—I. Metaphase. FIG. 3. II Metaphase. × 1200.

(Figs. 1-3). Previously Kawakami,[1] reported the chromosome number in this species which, according to him, is $n = 12$. His count seems to be incorrect. Hence the present report.

The basic number for the genus *Cassia* seems to be 7. Such a conclusion is based on the cytological investigations of some species of *Cassia* by the writer as well as on the previous reports of chromosome numbers in various speceis of *Cassia* by others (Senn,[2] Jacob,[3] Pantulu,[4] etc.). Where aneuploidy does not occur, the chromosome number can be expected to be $n = 7$ or simple multiples of the same. In a few cases, where a different number was reported previously these reports were proved to be incorrect by subsequent workers.[2,3,4]

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*January* 2, 1946.

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## CHROMOSOME NUMBERS IN *SESBANIA*

THE chromosome number in the genus *Sebania* Pers. was first reported by Kawakami (1930). Working with *S. aculeata*, he reported $16n$ chromosomes. Subsequently, Krishnaswamy and Rangaswamy Ayyangar (1935) found $n = 7$ in *S. grandiflora*. Senn (1938) reported 12 somatic chromosomes in *S. tetraptera*. Recently Jacob (1940), after cytological survey of the genus, showed that *S. speciosa* and *S. Sesban* are secondarily balanced tetraploids with a basic number 4. He reported lateral satellites in *S. grandiflora* and the relationship between the size of the satellite and of the nucleolus in *S. bispinosa*.

The genus appears to be interesting from the point of view of its variable and unrelated chromosome numbers. A study of the chromosome numbers in *S. grandiflora*, *S. ægyptiaca* and *S. aculeata* shows that some of the previous reports are incorrect. This can be inferred from the following table:—

| *Species* | *2n* | *n* | *Author* |
|---|---|---|---|
| *S. grandiflora* Pers. | .. | 12 | This paper. |
| | .. | 7 | Krishnaswamy & Rangaswamy Ayyangar (1935) |
| *S. aculeata* Poir. | .. | 6 | This paper |
| | .. | 16 | Kawakami (1930) |
| *S. ægyptiaca* Pers. | 12 | 6 | This paper |

If the previous reports are correct, they indicate polyploidy within species. It is not improbable, as remarked by Senn (1938), that some of the previously reported species belong to different genera. Cytological details of the above three species will be published elsewhere.

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*February* 27, 1946. Y. SUNDAR RAO.

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## CHROMOSOME NUMBERS IN SESBANIA SPP.

KRISHNASWAMI and G. N. Rangaswami Ayyangar[1] have previously reported that in *Sesbania grandiflora* (Pers.) the chromosome number is $2n = 14$ and $n = 7$. They also quote Kawakami's[2] observation on *Sesbania aculeata* (Pers.) who finds in this species $2n = 32$ and $n = 16$.

The common Sesbania species, *S. grandiflora* (Pers.), *S. aculeata* (Pers.) and *S. ægyptiaca* (Pers.), were studied for chromosome number and behaviour, and the findings are as follows. In *S. grandiflora* as well as in *S. aculeata* $2n = 24$ and $n = 12$ while in *S. ægyptiaca* $2n = 12$ and $n = 6$. As the photomicrographs

Division metaphase *S. grandiflora* P.M.C. Mitotic metaphase *S. aculeata*

show the chromosomes are well defined, large, and easy to count, and there are definitely more than seven bivalents in the pollen mother-cells of *S. grandiflora*, and less than 32 chromosomes in the cells in the root tip of *S. aculeata*. Large number of observations were made on meiotic and mitotic cells, and the material was obtained from plants grown locally. The numbers were constant in a species, and are consistent for the genus.

The present observation does not agree with those of previous workers. Probably the genus is quite variable as regards chromosome numbers. This variability is unusual when compared with the numbers in other species of Leguminosæ, as given by Gaiser.[3]

I am indebted to Dr. V. K. Badami, PH.D. (London), Principal of the College, and to Mr. S. Sampath, who supervised the work.

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College of Agricultural Research,
Benares Hindu University,
*March* 7, 1946.

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## DEVELOPMENT OF ENDOSPERM IN *LOBELIA NICOTIANAEFOLIA* HEYNE

THE gametogenesis, embryogeny and nature of endosperm haustoria in the mature seed of *Lobelia nicotianæfolia* Heyne have already been described by Kausik (1936). The present account deals with the mode of endosperm development in the same plant, certain details of which were not available earlier. After syngamy the primary endosperm nucleus divides by a transverse wall, producing the upper primary micropylar and the lower primary chalazal chamber. Next a vertical wall is formed in the primary micropylar chamber and slightly later a similar type of wall in the primary chalazal chamber too (Fig. 1). Subsequently these pairs of cells become divided transversely, first the upper pair and then the lower (Fig. 2); so the embryo-sac comes to be made up of eight cells, arranged in four tiers of two cells each. Of these, the two cells of the first tier develop into the micropylar

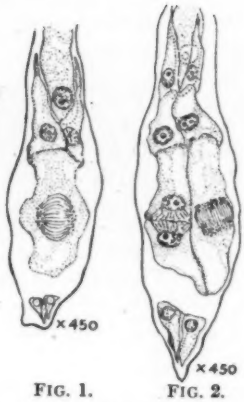


FIG. 1. FIG. 2.

haustorium, and the last pair of cells into the chalazal haustorium. The remaining two middle tiers form the endosperm tissue. The development thus follows the *Scutellaria*-type of Schnarf (1931). Endosperm development in *L. trialata* (Kausik and Subramanyam, 1945), however, differs in two minor respects from the one seen in *L. nicotianæfolia*; firstly, the vertical divisions in the primary micropylar and primary chalazal chambers are almost synchronous and secondly, at the four-celled stage of the endosperm the first transverse division takes place in the lower pair of cells earlier and subsequently in the upper pair. The *Scutellaria*-type of endosperm is also met with in the other species of the genus, namely, *L. amœna* (Hewitt, 1939), *L. trigona* (Maheshwari, 1944) and *L. trialata* (Kausik and Subramanyam, 1945).

Our sincere thanks are due to Mr. K. S. Gopalakrishnan for collecting the material and to Dr. L. N. Rao for kind encouragement.

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Bangalore,
*January* 31, 1946.

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## *TRICHOGRAMMA EVANASCENS* WESTW. (RACE *MINUTUM* RILEY), AN EGG PARASITE OF THE CASTOR SEMILOOPER MOTH *ACHAEA JANATA*, LINN.

DURING the course of the bionomics of the castor semilooper in 1943 in the Hyderabad State an egg parasite, *viz.*, *Trichogramma evanascens* Westw., was bred out of the eggs of *Achæa janata*. Some preliminary observations were made on this parasite and the results are summarised in this short letter.

*Host.*—The *Achæa janata* moths are nocturnal in habits. One to six eggs are laid on both the under and upper surfaces of the castor leaves. The eggs are laid singly. The egg is about 0·9 mm. in diameter. The eggs hatch out in 3-4 days. The caterpillars feed on leaves. The caterpillars when full grown either pupate on the leaf itself or in the soil. The total life-cycle lasts for about 28-47 days.

The parasite is pale yellow. Copulation starts soon after its emergence from the host egg and lasts for 2-3 seconds. Male is shorter than the female. The antenna in male is provided with numerous bristles. It is darker in colour. Soon after copulation the female goes round the host egg two or three times and after selecting a suitable spot, thursts its ovipositer and lays eggs. This operation lasts for 2-3 seconds. It has been observed that other wasps also lay eggs in the same host eggs. The parasitised eggs turn black within 48 hours. One to six eggs are laid in the host's egg by the parasite. The life-cycle lasts for five days.

The parasite breeds well in the eggs of *Corcyra cephalonica*. In the eggs of *Corcyra* the life-cycle of the parasite is completed in seven days.

The following table shows the incidence of *Trichogramma evanascens* in the *Achæ janata* eggs.

| Date | No. of eggs collected | No. parasitised | Percentage of parasitization |
|---|---|---|---|
| 28–6–1943 | 25 | 21 | 75 |
| 1–7–1943 | 30 | 27 | 90 |
| 19–7–1943 | 11 | nil | nil |
| 25–7–1943 | 27 | 12 | 44·4 |
| 28–7–1943 | 62 | 43 | 69·8 |
| 4–8–1943 | 32 | 21 | 65·8 |
| 8–8–1943 | 39 | 36 | 73 |
| 19–8–1943 | 22 | 22 | 100 |

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## REFECTION PRODUCING BACTERIUM

REFECTION is a phenomenon discovered by Fridericia and his collaborators in Copenhagen. It relates to a condition that sometimes appears in experimental animals, mainly rats fed on vitamin B poor diet and characterized by normal growth in spite of this apparent deficiency. The excretion of such rats is usually white due to undigested starch. When potato starch is given the effect is still more pronounced than with rice starch, a fact which is difficult to explain. The important point about refection is that fæces contain vibrios which have not been cultivated so far but which are assumed to produce vitamin B. These vibrios were mostly found in the cæcum

of the rat. Through the kindness of Professor Scheunert in Leipzig I was able to procure such refected rats and I noticed that the hydrogen-ion concentration of such rats in the cæcal region corresponded to pH 6·6 while the normal rats in his laboratory had pH 6·8 in the same region. I had previously imagined that the intestinal fluids were rather alkaline to help tryptic digestion which, however, was not the case. Prune juice media with liver extract, maltose, yeast extract and peptone, without any meat extract, was used with pH 6·6 for cultivating these vibrios. The germs grew as impure cultures with *B. coli* and cultures were sent to Dr. M. Nathan who was working in Copenhagen under Prof. Fridericia about August 1938. These so-called vibrios grew like long chain of threads which were twined around an imaginary cylinder. There were also separate individuals. The growth of the colony was very thin and slow, that is, the sum-total of the individuals in a colony was very unlike a typical bacterium. The surface of such colonies resembled pictures of the germ of syphilis as grown by Prof. Reiter or like some delicate Mycobacterium. This habit explained very well how refection is a slow process, the germs by nature are not prolific so that the secretion of vitamin B takes place in minute doses which prolongs the period of recovery from vitamin B deficiency ending in refection. As the war is happily at an end it is appropriate to publish this small note. The work was done at the Institute of Hygiene, Leipzig, where I have to thank Prof. Dresel, its Director.

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## NEW SPECIES OF HYMENOPTEROUS EGG PARASITES OF *LEPTOCORISA VARICORNIS* F. AND *ASPONGOPUS JANUS* F.

N. C. PANT AND P. S. DUHAN, during the course of their investigations in 1944 on the bionomics of the pests, obtained hymenopterous egg parasites from the egg masses of *Leptocorisa varicornis* F. (Hemiptera, Coreidæ) and *Aspongopus janus* F. (Hemiptera, Pentatomidæ). These egg masses were collected from the fields at Cawnpore. The specimens were sent to the Director, Imperial Institute of Entomology, London, for identification. Through the courtesy of Dr. S. A. Neeve, the Director, Mr. Nixon, has kindly placed the specimens reared from *Leptocorisa varicornis* F. in the genus *Hadronotus* (Scelionidæ) and the other reared from *Aspongopus janus* F. in the genus *Eupelmis* (Eupelmidæ). I have since compared these specimens with the descriptions of other known species of hymenopterous egg parasites in these families and find that there are certain significant distinguishing characters to warrant them the status of new species. I have, therefore, named them as *Hadronotus varicorni* Pant., Sp. Nov., and *Eupelmis aspongopi* Duhan, Sp. Nov. Detailed descriptions of these parasites with full biological notes will be published in due course.

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Cawnpore, U. S. SHARGA.
*February* 12, 1946.

1. Mani, *Rec. Ind. Mus.*, 1936, **38**. 2. —, *Ind. Jour. Ento.*, 1939, **1**. 3. —, *Catalogue of Indian Insects*, 1941, **26**. 4. Pruthi and Mani, *Mem. Ind. Museum*, 1942, **13**. 5. Nixon, *Ann. Mag. Nat. His.*, 1938, 1938, **20**, 1, 2.

## BRIEF NOTE ON SOMATIC VARIATION IN "KENTS" STRAIN OF *COFFEA ARABICA* L.

So far no case of mutation of somatic variation appears to have been described on "Kents" strain of *Coffea arabica* L. The present note describes briefly a sucker—a case of somatic variation on "Kents" plant observed at the Government Coffee Experiment Station, Balehonnur. The plant is a graft, nine years old, made up of Netraconda hybrid stock and "Kents" scion. The graft union is about six inches from the soil level. The mutant sucker has developed well above the graft union—3 feet above the union, and about 9-12 inches below the topmost pair of primary branches. It has grown up to 4 feet above the primary branches. The branches on the sucker make a very acute angle with the main stem of the sucker (Fig. 1). They are whippy

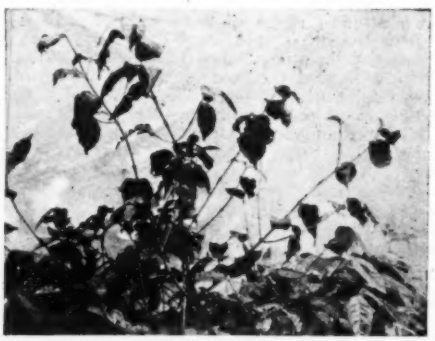

FIG. 1. A sucker—a case of somatic variation on "Kents" strain of *Coffea arabica* L., growing above the top-most pair of primary branches.

and are more vigorous in growth than the main stem of the sucker. Secondary system of branches is poor. The leaves on the sucker and its branches are very characteristic. The difference between the normal leaves on the 'Kents' plant (Fig. 2*a*) and those on the sucker (Fig. 2*b*) can be easily made out. The leaves on the sucker are broad at the base, thicker and coarser in texture, and crinkled in appearance. The veins make a very acute angle with the mid-rib and are curved. The flowers on the sucker appear to be normal except for the broader corolla lobes which give the flowers a

distinct appearance. A number of "Star flowers"—immature flower buds opening out even when quite green—are noticed on the sucker. No fruits have developed on the sucker.

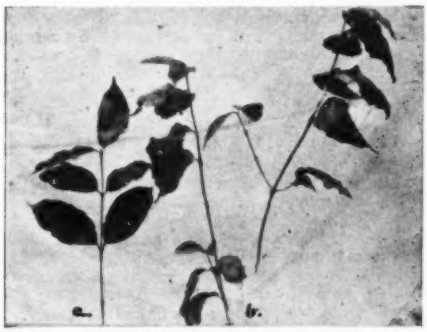

FIG. 2*a*. Normal leaves of the "Kents" plant.
FIG. 2*b*. Branches of the sucker showing leaves with broad base, coarser texture and crinkled appearance.

Krug (1938) mentions, " ... most of them (the variations) are gene mutations; the mutant branches are characterised by much smaller leaves and more intensified secondary branching, the internodes being generally much shorter ... A few cases of chromosome duplications were observed, a normal tetraploid plant producing octoploid Bullata branches; in two individuals vegetative reduction to half the chromosome number (Octoploid to Tetraploid) occurred. ..."

The morphological description given by Krug (1938) for the octoploid Bullata branches produced on a normal tetraploid plant appears to agree closely with the description of the variated sucker of the present note so far as the characters of the leaves and flowers are concerned. A full paper will be published elsewhere.

My thanks are due to Mr. K. H. Srinivasan, M.A., B.SC. (Edin.), Deputy Director of Agriculture, Bangalore, for his kind encouragement.

R. L. NARASIMHA SWAMY.
Govt. Coffee Experiment Station,
Balehonnur,
*January* 16, 1946.

1. Krug, C. A., *Variações Somáticas em Coffea Arábica* L., Instituto Agronomico Do Estado, Em Campinas Boletim Tecnico, 1938, **20**,8–10.

## A *RHIZOCTONIA* LEAF BLIGHT OF *DIOSCOREA*

*Dioscorea alata* L. (*Yam*) which grows wild throughout Assam is also cultivated to a limited extent in certain localities. Its tubers constitute an important article of food, and in times of famine it is of the greatest possible value. A severe leaf blight of this plant due to a species of *Rhizoctonia* was noticed for the first time at Sylhet in July 1944.

The first symptoms of the disease appeared on the lower leaves, which were in contact with the soil. Affected tissues were characterised by a clearly defined, water-soaked areas which progressed rapidly over the leaf. Within a short time the infected area collapsed and became flaccid turning from green to a dead brown. More or less concentric zones of light and dark brown colour were often observed, spreading from an infection centre. Following collapse of the leaf blade the infection spread down the petiole to the stem, where the other leaves and the stem became involved. Severe-blighted leaves often showed scattered strands of coarse mycelium traversing their surfaces. Fig. 1 shows the symptoms of the disease.

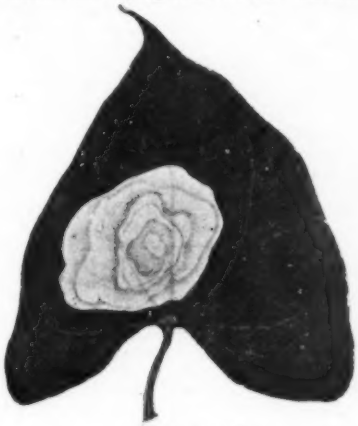

FIG. 1 × 1

A large number of isolations was made from the diseased tissues and a species of *Rhizoctonia* was always obtained in culture. All the isolates were identical. A large number of inoculation experiments was carried out and the pathogenicity of the fungus established. It was found that under damp humid conditions the parasite is rather virulent.

The morphological and physiological characters of the fungus were studied in culture and, by comparing it with a culture of *R. solani* Kühn, it was identified to be that fungus. Inoculation experiments carried out with the *Dioscorea* isolate on potato and with the potato isolate on *Dioscorea* further confirmed this identification.

The method of penetration of the fungus was studied. Leaves wounded and unwounded were inoculated at particular points by bits of the fungus hyphæ and kept in moist chambers. At 24 hours' intervals pieces of tissue cut out from around the place of inoculation were placed in a solution of equal parts of absolute alcohol and glacial acetic acid to remove the chlorophyll, then cleared in lactophenol to which acid fuchsin had been added.

The material fixed 24 hours' after inoculation showed no signs of penetration. After 48 hours' infection was macroscopically evident. Microscopic examination showed the mycelium traversing the surface of the leaves and small stromatic areas of knotted fungus strands distributed among the hyphæ. The stromatic areas or 'infection cushions' have been described by Duggar[1] as playing an important role in effecting penetration.

Initial penetration by the fungus takes place immediately beneath infection cushions and seems to be a mechanical process. The infection cushions appear to act as a fulcrum against which a force is exerted that is sufficient to allow hyphæ to penetrate uninjured epidermal cells. Infection cushions were formed on the lower as well as on the upper surface of all inoculated leaves regardless of the location of stomata. Wounded and unwounded leaves showed marked symptoms of infection within four to five days.

It is probable that in Nature the most highly pathogenic cultures of *R. solani* penetrate directly and are not dependent on wounds or stomata as avenues of entrance into their hosts. So far this fungus has not been reported on *Dioscorea*. This communication thus records the first report of its occurrence on *Dioscorea* leaves.

Plant Pathological Laboratory,
Sylhet, Assam, S. CHOWDHURY.
*January* 30, 1946.

1. Duggar, B. M., *Ann. Mo. bot. Gdn.*, 1915, **2**, 403-458.

## WILT OF PINEAPPLE IN ASSAM

FOR the last few years a wilt disease of pineapple [*Ananas comosus* (L.) Merr.] has been observed to occur in certain pineapple-growing tracts of Assam and found to cause considerable damage. Outbreaks of the disease are usually spasmodic in their occurrence but when an outbreak does occur it may spread over a wide area with great rapidity. So far the disease has not been reported from any other part of India. Outside India it has been known to occur in Queensland only (Lewcock, 1935).

The disease is prevalent during the rains and causes the greatest damage during periods of excessive rainfall. Plants one to two years old are most subject to attack, which invariably results in cessation of growth, both of suckers and parent plant. In the initial stages of the disease the leaves of the affected plants lose their normal dark-green colour and assume a drab olivaceous hue. At first limp and flabby, they quickly droop and fall to the ground. This collapse of the foliage is the most striking symptom of the disease. After the plant has collapsed the leaves wither, commencing at the tips, but the final stages of the disease are slow and complete shrivelling of the foliage may be delayed for months.

When a plant becomes affected by the disease while its fruit is still immature, the subsequent development of the fruit is arrested and it colours prematurely. This premature colouring of the immature fruit on the wilt-affected plant is preceded by a pronounced withering of the fruit stalk for several inches immediately below the base of the fruit. Despite the drying out of the fruit stalk, however, its rigidity is usually such as to maintain the fruit in an upright position. Detachment of a fruit from a withered fruit-stalk is a matter of comparative difficulty, a twisting movement being required to dislodge it. Prematurely coloured fruits from wilt-affected plants are spongy in texture and sub-acid to the palate. Consequently, they have no commercial value even when of marketable size.

Rotting of the roots is invariably associated with the foliage symptoms of wilt, in fact decay of the roots may well be advanced before any foliage symptoms become apparent. Affected plants are usually so lacking in roots that they may be pulled from the ground with little effort.

A large number of isolations were made from diseased specimens collected from the different pine-growing tracts. A species of *Phytophthora* was always obtained in culture. The pathogenicity of the fungus was established in the usual manner by isolation, culture inoculation, re-isolation and comparison.

The morphological characters of the fungus were studied in culture, and the fungus was identified as a strain of *Phytophthora parasitica* Dastur. In Queensland, the cause of pineapple wilt has been ascribed to *P. cinnamoni* Rands (Lewcock, 1935).

Studies on the contributory factors and methods of control of wilt are in progress.

Plant Pathological Laboratory,
Slyhet, Assam, S. CHOWDHURY.
*October* 22, 1945.

1. Lewcock, H. K., *Qd. agric. J.*, 1935, **43**, 9-17.

## HAIR BALL IN THE STOMACH OF A CALF

WHEN I came across Mr. D. Chakraborthy's letter on hair ball in the *Current Science* of February 1946, I thought that the following observations may be worth recording.

Experience in this laboratory shows that hair balls may frequently occur in the stomach of guinea-pigs. They have been found in experimental animals as well as in cases of spontaneous death. Sizes up to about two inches in diameter have been met with. They were black, fairly hard, spherical or oval in shape and difficult to break because of the fibrous structure. On breaking, they were found to consist of closely packed bundles of hairs held together by what apparently looked like the animal's excreta. Obviously, these balls take a long time to form and, as the animals are usually kept in groups, it was difficult to decide whether the hairs were from the same animal or from others. No attempt has been made to establish the source.

In no case was spontaneous death traceable to the effects of the ball. But it is difficult to imagine that such a big hard lump can exist in a relatively small stomach without producing any obstructive effects. In some cases, macroscopic abrasions of the mucous membrane of the stomach wall were visible on post-mortem examination.

Such balls have never been encountered in rabbits. Guinea-pigs in this laboratory are usually fed with sprouted Bengal gram and green leaf.

Bacteriology Laboratory,
Andhra Medical College,
Maharanipet,
Vizagapatam, N. G. PANDALAI.
*March* 4, 1946.

# REVIEWS

**The Chemistry of Cellulose.** By Emil Heuser. (John Wiley and Sons Inc., New York; Chapman and Hall Ltd., London), 1944. Pp. 660. Price $7.50.

Emil Heuser belongs to the select group of cellulose chemists who, in addition to their significant contributions to our knowledge of cellulose, have also written authoritative books on this complex subject. His "Lehrbuch der Cellulose Chemie" has long been a standard text-book of the student. Here now is a much more comprehensive volume which can only be adequately described as a monograph.

In comparison with many other organic compounds in nature, cellulose is essentially simple in structure being but a polymer of glucose anhydride (although it took years of research work by a large number of workers to reveal this simplicity). At the same time, the unusual arrangement of these molecules to form the framework of the vegetable fibres, the high molecular weight and colloidal nature of the various forms of cellulose invest this substance with properties which are by no means well understood. Also, the use of cellulose as raw material in many important modern industries resulted in much work being done on these applied aspects of cellulose chemistry and in turn has posed many fresh problems to the research worker. For an appreciation of these large fields of work in their true perspective and to adequately summarise our present knowledge of the subject required talents of an unusual order. And these find full expression in the volume under review.

The general plan of the book is simple and comprehensive. To start with, the author recognises that "in dealing with the chemistry of cellulose we cannot afford to neglect either its microscopic or submicroscopic morphological structure or, as a result of its high polymeric character, its colloidal nature—these peculiarities call for close consideration because they cause the reactions of cellulose to take a more or less heterogeneous course ..." To this extent, the volume includes a critical study of what are usually termed the purely physical properties of cellulose, under two chapters—morphology of the fibre and composition of cell walls (Chapter II) and the molecular weight of cellulose (Chapter XV). The chapter on Morphology also has an account of the formation of cellulose in plants.

The chemical properties of cellulose are discussed in twelve chapters and include all the important reactions of cellulose in its behaviour as a polyhydric alcohol and as a polysaccharide. The latter comprise the large number of reactions involving the degradation of the cellulose molecule to shorter chains. Th association of water with cellulose—whose exact mechanism and the nature of the resultant complex is controversial—forms a separate chapter. The action of aqueous alkalies also rightly claims a chapter as befits the theoretical significance and practical importance of the reaction. The effect of organic bases, ammonia and salt solutions, are clubbed together. The very large amount of work on the solution of cellulose in cuprammonium hydroxide is summarised in a masterly fashion. Then follow critical reviews of cellulose esters, xanthatas and ethers. The X and XI Chapters are devoted to the oxidation of cellulose and the decomposition of cellulose by acids. Lastly, the decomposition of cellulose by heat and by biological processes are themes which have received much too scant attention in the earlier treatises on the subject and greatly add to the usefulness of the present volume.

Two features of the book strongly impress the reader. The first is the wealth and comprehensiveness of the literature cited. Most of the more important papers on the subject right up to October 1943 have been garnered—a remarkable achievement under the prevailing war conditions for a volume published in 1944. The second feature is the objectivity with which the mass of data has been presented—by no means easy for an active worker in the field. Conflicting view-points are presented fairly and fully and there is no intrusion of the author's own appreciation of the probable truth. This detachment is so scrupulously maintained that in discussing the formation of cellulose in plants, he says, "It *seems* to be an established fact that the plant synthesizes carbohydrates from carbon dioxide and water by a photochemical reaction" (Italics ours). This cautious objectivity is characteristic of the monograph as a whole. And, while this assures the research worker a bird's-eye view of all the available data and leaves him free to draw his own conclusions—by reference to the original papers if necessary—this very virtue places the volume above and beyond the requirements of the average student.

The volume is provided with an author index and a subject index, both prepared with a thoroughness which is necessary. The printing and get-up of the book would do credit to the publishers even during normal times. Under war conditions, it is a feat in itself.

Emil Heuser's monograph is a notable contribution to the literature on cellulose in the English language. Cellulose chemists and technicians concerned with the industrial transformations of cellulose place themselves under a needless handicap by not possessing this volume.

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**Chromosome Atlas of Cultivated Plants.** By C. D. Darlington and E. K. Janaki Ammal. (George Allen and Unwin Ltd., London), 1945. Pp. 397. Price 12*sh.* 6*d.*

The authors have made a new approach to the study of the distribution of cultivated plants of the world different from the approach

made by taxonomists, who have hitherto depended for classification on morphological differences. Darlington's views on the limitations of earlier methods of taxonomists have been clearly expressed in his contribution on "Taxonomic species and genetic systems". The species concepts of earlier systematists break down when applied to certain families of plants. The question, therefore, arises as to the limit that should be set by which to judge the standard of fixity of species. There is no agreement on this point amongst systematists themselves. What may be considered a homogeneous species by the systematists, may easily prove not to be so when analysed from the point of view of genetics and cytology. It is these latter aspects of enquiry which Darlington and Janaki Ammal have applied in their study of the distribution of the cultivated plants of the world and of the diversity exhibited by them.

The authors have confined their attention to the cultivated plants of the world necessarily, because experimental breeding and chromosome study have been largely confined to these plants which are easy to work upon. The accumulated results obtained from over a quarter-century of experimental work of breeding and chromosomal investigations have been assessed and certain conclusions have been drawn which have helped to rearrange the taxonomic species in a differnt manner so that the homogeniety or diversity within a species is more clearly brought out.

In the introduction to the book which has been contributed by Darlington, a clear picture is given of the process at work in the production of variation and the grand process of evolution. Reference is made to the work of Vavilov, who by a thorough study of the cultivated plants of the world and their genetic diversity, was able to trace the centres of origin of the staple crop plants. The Vavilonian idea of the centre of origin of a crop plant associated with its maximum diversity is shown not always good. Centres of diversity of many crops have shifted, the causes for shifting being either a shift in the centre of greatest cultivation, changes in civilization or changes in natural conditions. Species and varieties have been improved and changed to a considerable extent by cultivation. The part that agricultural operations such as tillage, sowing and harvesting have played and the replacing of the methods of inbreeding by outbreeding and *vice versa* on the evolution of the cultivated plants are briefly explained. In the latter part of the introduction the role played by chromosomes in the development of cultivated plants and in causing diversity are broadly dealt with. The effect of selection and mutation within different systems of mating, polyploidization and the several other ways of chromosomal changes which bring about divergences of various types are enumerated. It is pointed out that these newer methods of analysis will be combined with Vavilov's methods to unravel the past of the cultivated plants.

It is admitted that the new classification on which charting of the chromosome atlas is based is to be understood as diagrammatic as it is the first attempt and as part of the classification is based on conjectural evidence and has not been experimentally verified. The significance of chromosome numbers in gauging the interrelationship of the species and in the results to be expected in species hybridization are pointed out. Within a morphological species, there may exist a polyploid series splitting it into what is called several "potential new species". Each member of a polyploid series is a genetic species isolated from another more strictly than are distinct morphological species with the same ploidy. It is pointed out that in the process of "evolution" "morphological groupings thus point backwards", that is, to the source of divergence and "chromosome groupings point forwards", that is, to the potentiality contained within a species to future development. The introduction concludes with the important statement, "For 30 years, cytologists and systematists have been discussing the bearing of chromosome change on classification in particular groups. Now from a summary of the total observation, we can get a bird's-eye-view of the whole process of the evolution of genetic systems in the flowering plants. It is only a bird's-eye-view, often indistinct and remote, yet already in sense, it shows the plan and the proportions of nature".

The chromosome atlas is a catalogue of cultivated plants based principally on the chromosome number. The arrangement of the families follow partly the older system of morphological classification, wherever it has been found desirable to retain such arrangements and in others the authors have followed a different method of grouping based on chromosome number. All these are fully explained in the portion on "Explanation of the catalogue". The catalogue gives the chromosome number of over 11,000 species belonging to 2,000 genera. Chromosome numbers of some of the species included in the catalogue remain to be determined. An extensive bibliography, a useful index and two maps, one each to show the cultivated and the wild plant regions of the world, are included. The importance of a book of this nature cannot be over-estimated. It will be of considerable help to geneticists, cytologists and to systematists who would now be able to assess the value of chromosomal changes on classification of plants into particular groups.

L. S. S. KUMAR.

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**Lubricating and Allied Oils.** By Elliot A. Evans. (Chapman and Hall Ltd., London), 1945. Pp. x + 210. Price 15/-.

The publication of the third edition of *Lubricating and Allied Oils* is to be welcomed. Due to wartime conditions, the results of recent investigations all over the world could not have reached all quarters, and the volume, which includes some of the latest researches in the field is, therefore, a distinct contribution to the literature on oils.

The author has revised and enlarged his well-known book in this edition with a view

to bringing the subject up to date. In so doing, some discrepancies have crept in. Thus on para 2, the time of carvings on the Egyptian tomb of *Ra-Em-Ka* is given as 2600-1700 B.C., whereas in a paper by Francis J. Licate (*Ind. Eng. Chem. Ind. Ed.*, 1938, 30, 550), the date given is 2100-2600 B.C. Then it is known, and the author himself mentions it in para 4, that in the pre-petroleum days the only lubricants which were available were the common fatty oils. But from the first paragraph of Chapter III, one is led to believe that the use of petrol was known earlier than of vegetable oils. The molecular structure of fats and oils is not so fragmentary now as depicted by the author. Even the quantitative study of the component glycerides in natural fats has been pursued since 1927. Very valuable and useful work on the chemical constitution of fats has been done by Hilditch and his associates at Liverpool.

It would have been better if only those oils which are used in lubrication had been taken up for detailed discussion; the drying oils like *Oiticica* (not *citicia* as printed on page 17) and linseed oils could have been left out conveniently. A wrong statement has been made in the last paragraph on page 52 in mentioning the soluble and insoluble sludges from oils used in gears and turbines. As is evident from the Tables on pages 52 and 53, the sentence should read, "Consequently it is not surprising that the benzene soluble is sometimes considerably *more* than the benzene insoluble", instead of "... considerably *less*".

The value of the book would have been enhanced, had the author discussed at length the merits and significance of the various tests described in Chapter VIII, instead of the practical details. For the latter more authoritative works like "*Standard Methods for Testing Petroleum and its Products*" by the *Institution of Petroleum Technologists* and "*A.S.T.M. Standards on Petroleum Products and Lubricants*" could be referred to.

Though the author's book on *Additives* which is under preparation will be greatly welcome, and will satisfy an important requirement, the descriptions in Chapter IV could have been rendered more explicit if this important subject had received some attention. The modern petroleum industry depends to a great extent on the additives that are used in stabilising the various products. This rather young, but by no means unimportant, branch of petroleum technology finds use in oxidation and corrosion inhibition, improving oiliness, film strength, viscosity index and detergency, pour points depressing, etc.

The author refers to the mineral lubricating oils compounded with small quantities (up to 5-10 per cent.) of vegetable oils, but he has omitted to mention the important researches carried out in recent years on the utilization of vegetable oils either as such, or in admixture with mineral oils, in much larger amounts (as much as 50 per cent.) for lubricating purposes. Apart from the fact that vegetable oils have a high degree of oiliness, low coefficient of friction and high film rupture strength, the utility of these oils for lubricating purposes cannot be under-estimated on account of several other important reasons. The mineral oil resources of the world, though large, are not evenly distributed, and there are many countries which do not possess them all. It is also believed that the world's mineral oil reserves cannot indefinitely cope, with the ever-increasing demand for lubricating oil and that a shortage will make itself felt in course of time. Efforts are being made, therefore, to find out methods for substituting vegetable oils for mineral oil lubricants. Vegetable oils develop rancidity and acidity, especially in presence of metals like iron and copper. Various inhibitors have been found to stabilize these oils against oxidation and polymerisation so that they may serve as efficient lubricants. Much of this work has been described by Balada, Freund and Thamm, and has been carried out in India by Aggarwal, Chaudhuri, Mukerji and Verman (*Bulletins of Indian Industrial Research*, Nos. 18 and 20). The author's idea as given on page 66 that oxidation inhibitors for vegetable oils are not known appears to be ill-founded. The work carried out by Aggarwal, Bhatnagar, and Verman (*J. Sci. and Ind. Res.*, 1943, 1, 261), on vegetable-mineral oil blends leads to this conclusion. A contribution which has already found extensive use in railways has been made by Bhatnagar and Ward on the compounded blown rape-mineral oil for axle lubrication. The fatty materials have also been used as agents for carrying active elements such as chlorine, sulphur and phosphorus in the mineral lubricating oils.

The matter contained in the chapters on "Mechanical Testing" and "Oils Employed", will no doubt be helpful to the practical engineer in the selection of a lubricant best suited for his machine. Description of oils for cables, chains, metal cutting, quenching, tempering and thermostats, has also been included in the chapter, most probably due to the reason that they are mostly derived from mineral origin. A short account of the fluids used in hydraulic brake mechanisms would have been very much to the point in the book under review.

The employment of various types of engines, especially internal combustion engines, whether on land or sea or in air, has greatly increased and will increase still further with industrial expansion. New problems on lubrication will arise with these developments. Any treatise, dealing with the recent aspects of this important subject will prove useful not only to practical engineers, chemists and physicists, but also to research workers engaged in this field. The book meets these requirements adequately and, therefore, deserves wide attention.

JOTI SARUP AGGARWAL.

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**Mr. Tompkins Explores the Atom.** By. G. Gamow. (Cambridge University Press), 1945. Pp. ix + 97. Price 10*sh.* 6*d.*

This book is a sequel to the author's *Mr. Tompkins in Wonderland.* It is certainly as good and useful as the previous book.

The book commences with a dream of Mr. Tompkins on Maxwell's demon. Herein,

the mathematical ideas of probability are extremely well brought out. This is followed by a dream on the gay tribe of electrons. In this chapter, the modern ideas of the outer structure of the atom are very lucidly explained. In the next dream which is given the title, "The woodcarver", our present ideas about the elementary particles and the nucleus and the atom come up for very clear description.

The three dreams are followed by an appendix of four lectures by the professor which inspired the dreams. These four lectures give a most complete and precise description of the structure of the atom and the formation of compounds. They also contain details of nuclear fission.

This book has been published at a time when we talk of the dangers of the atom bomb and the harnessing of nuclear energy for human welfare. Nobody in the world can afford to remain ignorant of the basic principles of this branch of physics. The book under review explains these principles clearly in a manner that an average man of some commonsense and intelligence can easily understand. As such, it is most welcome and should be read by everybody. Its real value can be gauged from the following fact. The reviewer received the book on the 2nd of January for reviewer. He finished it and kept it by the same night! But he could not see the book again for writing the review till the 9th of March. It wandered from hand to hand, from lady to lady, from doctor to doctor, from student to student, and so on. The reviewer only found a slip on his table: "Mr. — says he read Gamow's book and found it marvellous. I have taken it from him for a night Pardon my doing so", and so on. The reviewer talked to some of these readers and found that they *had* got a hang of our modern ideas!

The book is very well got up. There are a large number of illustrations and the printing is good. On the whole, the get-up is of the standard we have come to expect of the Cambridge University Press.

It is a popular book and it is extremely well written. It is written by one of the most well-known theoretical workers on nuclear physics. It is published at a time which is most opportune. Every man, woman and child must read it—even professional scientists.

Prof. Gamow and the Cambridge University Press are to be congratulated for having brought out such a popular and such a useful book at such a very opportune time.

S. V. CHANDRASEKHAR AIYA.

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**Physical Methods of Organic Chemistry, Vol. 1.** Edited by A. Weisberger. (Interscience Publishers Inc., New York), 1945. Pp. 736.

The theoretical development of organic chemistry that took place in the middle of the nineteenth century appeared to stagnate to some extent for nearly half a century. The contribution of a few physical chemists and mathematical physicists then gave a new impetus to organic chemists by giving a greater precision to the concept of atoms and molecules and the nature of the forces binding them. This led to new and improved methods of tackling organic compounds and their reactions. In his preface to the volume under review, the editor remarks, "The chemist, in order to acquaint himself with a certain physical method, has in the past been compelled to search through periodicals and specialised books. The present work has been compiled with the hope of relieving him of much of this burden". A perusal of the volume indicates that this claim is to some extent justified.

Till the beginning of World War II, scientific workers were more or less dependent on books in German for any thorough and comprehensive publication of an authoritative nature and during the past few years monographs in English have been coming from American publishers. One feature common to these is noticeable in the present publication: wherever possible one gets the name and address of the American Scientific Instrument Manufacturer from whom the instrument described is obtainable. This information is no doubt useful but one cannot help commenting on such indirect advertisements as an undesirable feature in a scientific publication.

The present volume contains sixteen chapters dealing with the following topics: Determination of melting and freezing temperatures; Determination of boiling and condensation temperatures; Density; Solubility; Viscosity; Surface and Interfacial tension; Properties of monolayers; Osmotic pressure; Diffusivity Calorimetry; Microscopy; Crystal form; Crystallochemical Analysis; X-Ray Diffraction; Electron Diffraction; and Refractometry. A fair amount of the experimental side is well described in the different chapters but the unevenness of a composite work by several authors is noticeable. A description of Beckmann's Freezing-point method in the opening chapter could have been completely omitted as the method can be found in the most elementary books on Physical Chemistry which an undergraduate handles. Though our knowledge of solvent-solute interactions is still inadequate, one cannot agree with the authors that the solvent for crystallisation must be decided by a trial and error process. The preparation of pure samples by crystallisation from melts does not seem to find a place in the chapter. The chapter on density determinations by Bauer is useful for its critical study and the valuable guide to the selection of method. The short chapter on Viscosity gives no new methods not available easily and is to be noticed only for its indication of the use in highpolymer chemistry.

The critical account by Harkins forms one of the best reviews in the volume and the section on Parachors rightly concludes with the statement, "The parachor is a useful additive function but not a reliable tool for deciding between alternative different possible structures."

The study of monolayers has proved a valuable tool in the investigations of organic and biological problems and rightly finds a place in the volume under review. The horizontal and vertical film balances are well described and all aspects of work in the field are considered. Attention is drawn to the absence of

temperature control in most of the work of the English school and the author is constrained to remark, "It is evident, however, that such methods cannot give high accuracy".

The chapter on Calorimetry gives a valuable account of the application of this method to the study of fast reactions while the one on Microscopy gives an organic chemist a bird's-eye-view of Chemical Microscopy as a tool for constant use. The remaining chapters maintain the general standard of the volume, the theoretical aspect being more prominent. The last chapter in the volume contains a useful account by Fajans on the additive characteristics of refractivity.

There is no mention of the price anywhere but a more serious omission is the absence of an index. One finds, for example, a table of the thirty-two classes of crystals according to the Schonflies Space Groups in the chapter on Microscopy while one would naturally look for it in the chapter on Crystal Form where it is not found!

The book will be found useful by advanced students of both Physics and Chemistry and also fulfils the demands of an organic chemist looking for a convenient tool for investigation. The equipment described is beyond the reach of most laboratories in this country but sufficient information is often found to enable one to build them up in a good workship.

S. V. ANANTAKRISHNAN.

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**The Birds of Kutch.** By Salim Ali. (Published for the Government of Kutch by Humphrey Milford, Oxford University Press), 1945. Pp. xviii + 175). Price Rs. 20.

This book follows the plan of treatment adopted by the author in his earlier publication, *Book of Indian Birds*, with which students of Ornithology are familiar. Though it purports to be the outcome of a survey it is eminently readable, having none of the harsh flavour of official reports. Assembled within the space of 175 pages is a body of interesting information of about more than 275 birds belonging to different groups, with special emphasis on features peculiar to Kutch and its close environs. The book is profusely illustrated. The photographic reproductions are excellent. The coloured plates are superb, all in perfcet conformity with the stimulating and enjoyable letterpress. Serious students of bird life will find the book helpful and inspiring, and those interested in a general way in the habits of birds occurring in their neighbourhood will find it fascinating.

Before Mr. Salim Ali was invited by His Highness Maha Rao Vijayarajji to conduct the ornithological survey of his State in 1943, there have been other scientists like Ferdinand Stoliczka, Hugh Palin and C. D. Lester in the field since 1872, but none of them can be supposed to have enjoyed the opportunities which were accorded to the present author, whose efforts are reflected by the illuminating book he has produced. He declares that the birds of Kutch are fortunate in their rulers, whose love for these feathered subjects, extended frequently beyond the limits of field observation and sympathetic study. An article which H. H. Maha Rao Vijayarajji wrote in 1912 on Goose-Shooting in Kutch is reproduced from the *Journal of the Bombay Natural History Society* together with two photographs, which tell a gruesome tale of the destructive power of fire-arms in the hands of a bird-lover.

From the standpoint of physical features, the State of Kutch, which is almost treeless, rocky and barren, with ranges of hills and occasional wooded valleys and with scarcely 14 inches of rainfall, may not be deemed very propitious for harbouring a plentiful stock of varied birds. The country is traversed by a wide stretch of sandy waste lying athwart the face of the country as a broad band from East to West, known as the Great Rann, which during the South-West Monsoon becomes heavily inundated. "But the chief interest of Kutch Ornithology lies in the geographical position of this narrow strip of land relative to the mighty tide of migration that sweeps into India from beyond its northern and north-western boundaries and out again in the autumn and spring of each year". Kutch, therefore, standing at the junction of these migrational streams offers unrivalled opportunities for observation of the annual visitors, and Mr. Salim Ali suggests the erection of observation posts at suitable centres where competent observers would be in a position to collect information of great interest to science, throwing light on some of the obscure problems of the phenomenon of migration. Further the study of the influence of barriers on the distribution of birds, restricting their local migration offers fresh problems, for the Great Rann seems to have produced two "well-marked distinctions between resident bird-population of Kutch and that of the adjacent dry areas of Sind, Northern Gujerat, Western Rajputana and the northern portions of the Kathiawar Peninsula". The existence of the Great Rann, therefore, invests the resident bird-population of Kutch with a closer affinity with that met with in Gujerat than in Sind and Baluchistan.

The description of both resident and migratory birds is conveniently divided into sections of size, field characters, status and distribution, habits and nesting. The more serious students of ornithology are provided with brief paragraphs giving measurements,—"mostly wing and tail"—and other systematic details. Kutch is interesting to naturalists as the Great Rann is known to be the only breeding ground in India of the Flamingo of which the book provides a good description. The other features of this attractive book are a map, interesting prefatory and introductory notes and Index. We have no doubt that this excellent book will be placed in the libraries of all public and academic institutions, where we confidently hope that students of Biology will make the best possible use of its great treasure.

C. R. N.

**Education in India To-day.** By P. M. Limaye, M.A. (Published by Dr. D. D. Karve, M.Sc., Ph.D., Fergusson College, Poona), 1945. Pp. iv + 140. Price Rs. 2.

This book is the outcome of a tour to various educational centres in India in order to study the organization, practices and problems of schools and colleges. The itinerary given at the end of the book indicates the wide area covered by the author. The specific purpose of the tour, and the manner in which it was made possible for the author to undertake it, are explained in the Introduction.

The book is remarkable not merely for the information which it presents but more for the critical observations which it contains. Mr. Limaye is a retired life-member of the Deccan Education Society, and as such he naturally brings to bear a new and refreshing viewpoint upon all educational questions. His is a comparative study of the place which the Bombay Presidency occupies in the world of Indian educational progress. He starts with conditions in that part of India and surveys the various aspects of education elsewhere

Referring to the slow growth of literacy in the country he draws attention to the failure of Government to utilize private agencies in a larger measure. In a later chapter on private effort in education he criticises the Sargent Report for its departure from the repeated pronouncements of Government since 1854 (Wood's despatch) as to the need for implementing private agencies and private generosity in the establishment and maintenance of schools and colleges. He makes a powerful plea for improving the salary scales of all grades of teachers and criticises the niggardly policy of Government in the framing of grant-in-aid rules. In this connection he pays a well-deserved tribute to the selfless workers of the Deccan Education Society and to the staff of Fergusson College, Poona.

It is refreshing to note that the author does not uncritically endorse all the features of the Wardha Education Scheme but points out the dangers that we are in in the overemphasis of craft work. He is of the opinion that primary education cannot be rendered self-supporting.

The problems of secondary education are viewed in the light of the latest official reports of England and India, and the need for developing different types of schools with a practical bias is stressed. In a later chapter he reverts to the same problem and makes a critical survey of the proposals contained in the Reports connected with the names of Sir M. Visvesvaraya, Abbot and Wood, and Sir John Sargent.

The author has a great deal to say on University education. He discusses in some detail the aims of a modern University, the place of affiliated colleges in the scheme of higher education, the value of the tutorial system, the maintenance of examination standards, the study of English, and the promotion of corporate life in the colleges. A special sub-chapter is devoted to the proposed Poona University scheme.

Finally, in the closing chapter, brief references are made to certain educational projects and their possible application to Indian conditions. The book is throughout marked by earnestness and independence of thought, keen observation and critical judgment. The general get-up of the volume is good, but one would wish that more attention had been paid to the elimination of typographical errors. An index would have been useful.

D. S GORDON.

**Aircraft Engines, Vol. I.** By A. W. Judge. (Chapman & Hall, London), 1945. Pp. xii + 492. Price 28/-.

Beginning with aerodynamics, it works through combustion, and fuels to carburettors, supercharging, cooling and altitude effect, with a final chapter which deals with the gas turbines and jet propulsion. Thoroughly up to date so far as published work permits, it deals in detail with the working principles of the subject and is profusely illustrated. The results of recent experimental work are summarised with the help of data and diagrams, and full references are given to the sources of work. There is an index of subjects and authors, and an appendix which includes tables of standard atmospheres. The illustrations and the general lay-out are both excellent.

The book is of a convenient size to the student of the subject. It offers no examples to work out, a common defect in books of this nature, and so is a conveniently small work of references rather than a teaching book. As a summary of research and working principles, it should appeal both to the technical and the practical man, to the air force officer as well as the engineer.

R. G. HARRIS.

**An Elementary Text-Book of Inorganic Chemistry.** By Ramani Mohan Roy. (The Book House, Calcutta), 1945. Pp. viii + 506. Price Rs. 3-12.

This book forms a welcome addition to the large number of good text-books that are already available for an Intermediate student. The general plan of the book is designed to meet the requirements of the Intermediate syllabus of the University of Calcutta and the last chapter (38) dealing with Ba, Sr, Cd, As, etc., has not yet been added to the book under review. It has to be pointed out that the addition of this chapter is very important since the matter of this chapter is included in the syllabus of many of the Indian Universities. It is happy to note that principles of physical chemistry necessary to understand some of the chemical processes have been nicely dealt with at appropriate places and a good deal of stress is laid on the importance of working out numerical problems. The author has very well realised the difficulties of the teacher and the taught in introducing the subject of chemical formulæ and equations and has given the derivations of many of the difficult equations. It would have been far simpler for a student to derive the formula of a compound by dividing the weights of each of the elements in a gm. molecule of the compound, by their respctive atomic weights, instead of the classical G.C.M. method described in the book.

In his anxiety to make the text-book a self-contained unit, the author has devoted seven pages to give a brief outline of the qualitative analysis. The information given in this chapter is too meagre and the student has to consult text-books on qualitative analysis to get the required information. This chapter could have been very much enlarged by omitting unnecessary description of some elementary topics like filtration, construction of a barometer, etc. In spite of the author's attempt to give an account of 'manufacturing processes now in use', it is strange to find him devoting too much of space for Welden's method of manufacture of chlorine from hydrochloric acid. In fact the modern practice is to manufacture hydrochloric acid from chlorine. The author seems to think (p. 246) that chlorine is not manufactured on a large scale because the caustic soda that is simultaneously produced has no market. On the other hand, the problem of the day is to find new methods of utilisation of chlorine manufactured in the alkali industry. 'Sublimation' has been defined as vapourisation of the solid with or without passing through the liquid state; this mistake has to be rectified. The illustrations, *viz.*, heating of ammonium chloride for sublimation and separation of water from alcohol by fractional distillation, are not apt.

M. R. A.

**The Charnockite Rocks of Mysore (Southern India).** By B. Rama Rao. (Bulletin No. 18, Mysore Geological Department), 1945. Pp. 199, with maps, photographs and photomicrographs. Price Rs. 3.

This Bulletin is a detailed account of the results of twenty-five years of his investigations on the Charnockite and allied rocks of Mysore. It is divided into nine sections. The first section is an introduction to the study of charnockites, with special reference to the work done at different periods by the officers of the Mysore Geological Department. The older officers of the Department generally accepted Holland's view of a plutonic igneous origin for these rocks. But, Rama Rao's detailed studies in the field and the laboratory have revealed a number of evidences in support of a metamorphoric origin for the charnockite rocks in Mysore. Section 2 gives, in brief, a classification of these rocks. The third section describes the chief distinguishing characters of charnockites in general. The Mysore rocks are similar in all the characters to the typical charnockites, except in showing certain differences, like variation in texture, absence of hypersthene in some rocks showing charnockitic characters, and the occurrence (though rarely) of sphene. Section 4 gives a general summary of the mineralogy of these rocks and stress is laid on the secondary origin of hypersthene in them. The fifth Section, the largest, gives detailed descriptions of the petrography of all the rock types belonging to the charnockite series, which include the following: ultrabasic, basic, intermediate, and acid rocks, the charnockite dykes, and the charnockitic rocks. Section 6 is a comparative study of the chemical compositions of the charnockites of Mysore with those of other areas. In Section 7 some important exposures (14 in number) of these rocks and their field relations to associated rocks are described with the help of maps. Section 8 gives briefly a comparison between the chrnockite rocks of Mysore and those of Holland's type area of Madras.

Section 9, the last chapter, deals with the most important question of the mode of origin of these rocks. It begins with a chronological review of researches on this subject. Next evidences collected in Mysore, favouring a metamorphic origin, are given. The age of the rocks in Mysore is also discussed. Rama Rao concludes that these rocks belong rather to a metamorphic province than to an igneous petrographic province, wherein "the combined series of alterations under different periods of metamorphism of a composite series of rock formations of different ages, have given rise to a series of hypersthene granulites of very variable composition".

The publication, being an exhaustive summary of the results of intensive work of over two decades on a variety of rock types belonging to the charnockites, will be welcomed as an important contribution to the literature on this complex series of rocks and is bound to help and stimulate further research in this field.

M. V. N. Murthy.

## SCIENCE NOTES AND NEWS

**University of Travancore—Council of Research.**—The Fifteenth Annual Report presented by Dr. K. L. Moudgill, Vice-Chairman, to the Council, records the progress of work for the year on a wide front. The general overall impression produced is that Travancore is fortunate in having an organisation which secures active and fruitful co-operation between industry and scientific research, each nourishing and being in turn nurtured by the other.

The Council proposes to open a Department of Applied Chemistry and, the establishment of a chair in Mineral Research has been made possible by a munificent endowment by Dr. Rm. Alagappa Chettiar. And, amongst the schemes already under way, mention may be made of a model salt factory to be opened in an area of 8 acres. The production of agar-agar continues. Pyrethrum plantations are to be extended to 100 acres. And, although the pyrethrin content of the Travancore flower 0·5 per cent., is modest, it is interesting to note that the stalks of the flowers are reported to contain as much as 0·13 per cent. pyrethrins —a finding which does not agree with much of the published work on the subject. Experi-

ments are also in progress on the production of charcoal from indigenous woods and on their destructive distillation. The most extensive data on this subject have been collected at the Mysore Iron and Steel Works, Bhadravati, and it would appear that co-operative endeavour in this field might well ensure avoidable duplication. A subject of great importance and of topical interest (the question was raised only this month in the House of Commons) is the State's resources in Monazite and Ilmenite with their potential bearing on atomic energy. The Council proposes to tackle this problem. The importance, complexity and resources needed for adequate and rapid progress in this field are such that perhaps India as a whole would gain and the State would lose nothing if the problem was taken up by an All-India Organisation. The Public Health Laboratory continue[a] its work on nutritional studies and on cholera vibrios. In the Applied Biology Section striking progress has been made in the Tapioca Farm which now has 72 varieties registered and where some 1,000 intervarietal hybrids have been raised. The Entomological Section has, amongst other problems, been working on a question of all-India interest the susceptibility of bamboos to insect attack. Under Agricultural Chemistry, the work on soil surveys is being continued and a start has been made on base exchange phenomena in paddy soils. The Council has been able to secure the interest of private firms in the opening of deep-sea fisheries and curing yards which the Government propose to encourage.

The above are merely the high-lights of an interesting and informatory Report at the conclusion of which the Vice-Chairman points out that many of these schemes have been influenced by the stresses and requirements of war. We can only share his hope that the cessation of these abnormal conditions would not mean any diminution in the encouragement—in the broadest sense of the term—to the Council of Research of the University of Travancore.

**Atomic Research Committee.**—On the recommendation of the Board of Scientific and Industrial Research, the Governing Body has set up a Committee under the Chairmanship of Dr. H. J. Bhabha, F.R.S., to explore the availability of raw materials in India capable of generating atomic energy, suggest ways and means of harnessing them and keep in touch with similar organisations in other countries.

**Schemes of Industrial Research.**—The construction of a Technological Block of the Glass and Ceramic Research Institute in Calcutta at an estimated cost of Rs. 2,21,000, a block grant of Rs. 60,000 per annum to the Madras University for meeting the cost of a Leather Research and Technological Institute and a grant of Rs. 75,000 per annum to the Tata Institute of Fundamental Research, Bombay, for work on Astrophysics and Experimental Physics and Cosmic Ray Research, were lately approved at a meeting of the Governing Body of the Council of Scientific and Industrial Research.

**American Road Experts to Visit India.**—With the concurrence of Provincial Governments the Government of India have invited two top-ranking Public Works and Road Officials—Major-General Philip B. Fleming, the head of the Federal Public Works Administration, and Mr. Thomas Harris MacDonald, head of the Federal Bureau of Public Roads,—from the United States to pay a short visit to India, to advise generally on India's large programme of road development. Owing to their other important duties, the services of these two distinguished officials have been spared by the Government of the United States with great difficulty, but the President of the United States has agreed to their spending about one month in India during which time they will be the guests of the Government of India and will see as much of India's road system as possible in the time available.

**British Aviation Experts for India.**—The Civil Aviation Office of the Government of India is being expanded to meet the requirements of the programme for the development of India's air transport services and civil flying. As a first step towards this three specialist officers have been recruited in England. These officers who have taken up their appointments in Delhi are Air Vice-Marshal Sir Edward Rice, who becomes Deputy Director-General (Aircraft); Air Commodore E. I. Bussell, who has been appointed Director of Licensing, and Mr. J. P. Jeffcock, who becomes Director of Communications. Mr. Jeffcock is on three years' contract while both Sir Edward Rice and Air Commodore Bussell are on five years' contract.

Dr. P. V. Nair, M.Sc., D.Phil. (Oxon.), has been appointed Professor of Applied Chemistry in the University of Travancore. Dr. Nair is a former pupil of Sir Robert Robinson, Pres. R.S., Waynflete Professor of Chemistry in the University of Oxford, and worked at the Universities of London and Oxford.

We acknowledge with thanks the receipt of the following :—

BOOKS

1. *Vitamins and Hormones*, Vol. III. By R. S. Harris and K. V. Thimann (Editors). (Academic Press, Inc., New York, N.Y.), 1945. Pp. xv + 420. Price $6.50.

2. *Advances in Carbohydrate Chemistry*, Vol. I. By W. W. Pigman and M. L. Wolfram (Editors). (Academic Press Inc., New York, N.Y.), 1945. Pp. xii + 374. Price $6.00.

3. *Electron Optics and the Electron Microscope*. By V. K. Zworykin *et al.* (Messrs. John Wiley & Sons, Inc., N.Y.), 1945. Pp. xii + 766. Price $10.00.

4. *A Text-Book of Elementary Astronomy*. By Ernest Agar Beet. (Cambridge University Press, London), 1945. Pp. x + 110. Price 8/6.

5. *An Introduction to the Theory and Design of Electric Wave Filters*. By F. Scowen. (Chapmann and Hall, Ltd., London), 1945. Pp. xii + 164. Price 15/-.

6. *Roads for India*. By T. R. S. Kynnersley. (Tata Sons, Ltd. publication. Published by Messrs. Padma Publications, Bombay), 1945. Pp. 55. Price Re. 1.

263-46 Printed at The Bangalore Press, Bangalore City, by G. Srinivasa Rao, Superintendent and Published by Dr. M. A. Govinda Rau, M.A., Ph.D., for The Current Science Association, Bangalore